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PARIS OFFICE OF THE FAURE ELECTRICAL ACCUMULATOR COMPANY.

THE STORAGE BATTERY In PRACTICAL USE.

The Means Adopted to Apply the Faure Accumulator to the Affairs of Life.

THE GENESIS OF THE ACCUMULATOR—THE DIFFERENCE BETWEEN THE PLANTE AND THE FAURE—THE CONDITION OF STORAGE BATTERIES AND FUTURE POSSIBILITIES—THE THEORY UPON WHICH IT IS CONSTRUCTED AND JUST HOW IT WORKS—THE ELECTRICAL TRAIN—THE STREET CAR—THE TRICYCLE—THE MARINE LIGHTS—THE SEWING MACHINE—THE CUTTING MACHINE—THE PRINTING PRESS—THE TURNING LATHE.

Among the great discoveries in electrical science, the secondary battery may safely be said to tower head and shoulders above all the rest. Not that it has accomplished more than the others, for this is by no means the case. The electric-light, the telephone, the telegraph and many other contrivances have made far greater progress, but all these have a pretty accurately defined limit of usefulness. Not so with the secondary battery. Its future possibilities for usefulness are so great that he would indeed be a bold, if not a rash, man who should predict for it a circumscribed field of action. It is true that several important improvements must yet be made before the secondary battery may be looked upon as a thoroughly economic success, but we have the assurance of the most eminent electricians that the chances of this, judging from the progress already made, are far greater than were those, at a similar period of development, of some of the most important of the mechanisms which now are in daily use throughout the world.

If a man could lift himself up by the waist-band of his trousers, the construction of a mechanism which should enable him to fly would be a work of little difficulty. But a well-charged storage battery contains a power sufficient to lift it up miles in the air, to turn a machine that is heavier than itself and to transport it along a road. It is instilled with mechanical life, and, best of all, its motions and its power can be easily directed and controled.

So interesting a contrivance cannot fail to interest the general public as well as electricians, and as illustrations of a novel and therefore not generally understood mechanism always serve to make explanations and descriptions better understood, the New York ELECTRICAL REVIEW presents to its readers in this number careful drawings of the various applications of the Faure secondary battery.

At starting it may perhaps be as well to explain to those not familiar with the subject the difference between the Planté and the Faure secondary pile. In Planté's battery, the formation of the current is limited by the thickness of the leaden plates. Faure gives to his couples an almost unlimited power of accumulation by covering the

electrodes with a layer of spongy lead. In a pile of seventy-five kilogrammes he is able to store a quantity of energy sufficient to furnish a horse-power for an hour.

The chemical changes which take place during the charging and discharging of the storage battery have been the subject of much contention amongst chemists and physicists. Some are of the opinion that lead sulphate plays an important part, others that no chemical change of the sulphate occurs either in the charging or discharging of the plates, and finally, it is asserted, that much of the storage effect depends upon the occlusion of oxygen and hydrogen gases by the positive and negative plates, or by the active material therein. Prof. Frankland, an eminent authority, was convinced, after a series of careful examinations, that occluded hydrogen gases begin to be discharged from the plates; that is to say until the current is occupied exclusively or nearly so, in the electrolysis of hexabasic sulphuric acid expressed by Burgoin in the following equation:

	Eliminated on + plate	Eliminated on − plate
$SO_6H_6 =$	$SO_3 + 3O$	$+3H_2$
Sulphuric acid	Sulphuric anhydride	

The sulphuric anhydride immediately combines with water, of course, and regenerates hexabasic sulphuric acid:

$$SO_3 + {}^3OH_2 = SO_6H_6.$$

On discharging the cell, Prof. Frankland says, the specific gravity of the acid continually decreases until the discharge is finished, when it is found to have sunk to about the same point from which it began to increase during the charging. Hence, he says, it is evident that, during the discharge the lead sulphate, which was continuously decomposed in charging, was continuously reformed in discharging.

Thus, as will be seen, the principal, if not the only, chemical changes occurring during the charging of a storage battery would seem to be the following:

1st. The electrolysis of hexabasic sulphuric acid according to the equation already given.

2d. The reconversion of sulphuric anhydride into sulphuric acid.

3d. The chemical action on the coating of the + plate:

$$SO_4Pb + O + {}^3OH_2 = PbO_2 + SO_6H_6$$

lead sulphate. Lead peroxide. Hexabasic sulphuric acid.

4th. The chemical action on the coating of the negative plate:

$$SO_4Pb + H_2 + {}_2OH_2 = Pb + SO_6H_6$$

Lead sulphate. Hexabasic sulphuric acid.

The initial action, the professor says, in the charging of a storage cell, is the electrolysis of hexabasic sulphuric acid, each molecule of which throws upon the positive plate three atoms of oxygen, and upon the negative plate six atoms of three molecules of hydrogen. Each atom of oxygen decomposes one molecule of lead sulphate on the positive plate, producing one molecule of lead peroxide and one of sulphuric anhydride, the latter instantly uniting with three molecules of water to form hexabasic acid.

These are the chemical changes which are said to occur during the discharge of a storage cell:

1st. The electrolysis of hexabasic sulphuric acid, as in charging.

2d. The reconversion of sulphuric anhydride into hexabasic sulphuric acid, as already described.

3d. The chemical action upon the coating of what was before the positive plate or electrode, but which now becomes the negative plate of the cell—that is to say, the plate from which the positive current issues to the external circuit:

$$PbO_2 + H_2 = PbO + OH_2,$$

Lead peroxide. Lead oxide. Water.

The lead oxide thus formed is immediately converted into lead sulphate:

$$PbO + SO_6H_6 = SO_4Pb + {}_2OH_2.$$

4th. The chemical action upon the coating of what has now become the positive plate of the cell:

$$Pb + O + SO_6H_6 = SO_4Pb + {}_2OH_2.$$

Then in discharging, as in charging a storage cell, says the professor, the initial action is the electrolysis of hexabasic sulphuric acid. The oxygen eliminated on the positive plate reconverts the reduced metal of that plate into lead oxide, whilst the hydrogen transforms the lead peroxide on the negative plate into the same oxide, which in both cases is immediately converted into lead sulphate by the surrounding sulphuric acid, thus restoring both plates to their original condition before the charging began.

An ingenious means of estimating the charge in a storage cell was quite recently discovered by Prof. Frankland. The specific gravity and consequent strength of the dilute sulphuric acid of a "formed" cell being known in its uncharged, and also in its fully charged condition, it is only necessary to take the specific gravity of the acid, at any time, in order to ascertain the proportion of its full charge which the cell contains at that moment; and if the duty of the cell is known, the amount of energy stored will also be thereby indicated.

Thus in the case of a cell containing seven quarts of dilute sulphuric acid, each increase of .005 in the specific gravity of the dilute acid means a storage of energy equal to 20 ampères of current for one hour obtainable on discharge.

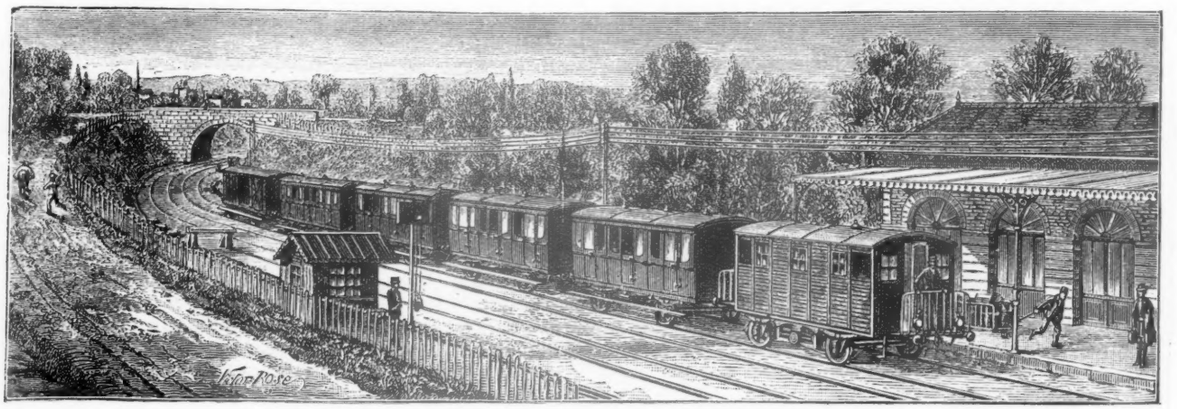

FIG. 1.—TRAIN RUN BY FAURE ACCUMULATORS.

gases play, practically, no part in the phenomena of the storage cell.

With regard to the function of red sulphur in storage batteries he observed that during the so-called formation of a storage cell a very large amount of sulphuric acid disappears from the liquid contents of the cell; indeed sometimes the whole of it is withdrawn. The acid so removed must be employed in the formation of insoluble lead sulphate upon the plates, which, in fact soon become coated with a white deposit of the salt, formed equally upon both positive and negative surfaces. This visible deposit is, in the opinion of Prof. Frankland, however, very superficial, and does not account for more than a very small fraction of the acid, which actually disappears from solution. The great bulk of the lead sulphate cannot be discovered by the eye, owing to its admixture with chocolate-colored lead peroxide.

Unless the coated plates have been previously immersed for several days in dilute sulphuric acid, this disappearance of acid, during their formation continues, he found, for ten or twelve days. At length, however, as the charging goes on, the strength of the acid ceases to diminish, and soon afterwards begins to augment. The increase continues until the maximum charge has been reached, and abundance of oxygen and

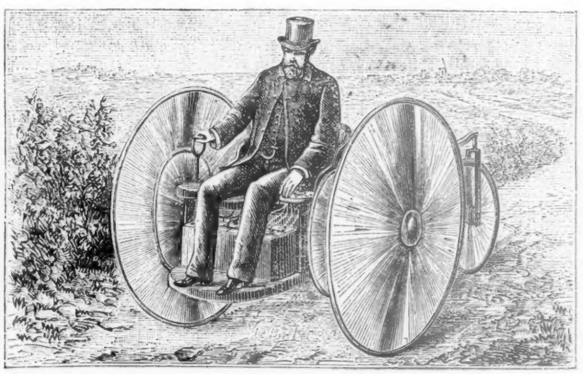

FIG. 3.—ELECTRIC TRICYCLE.

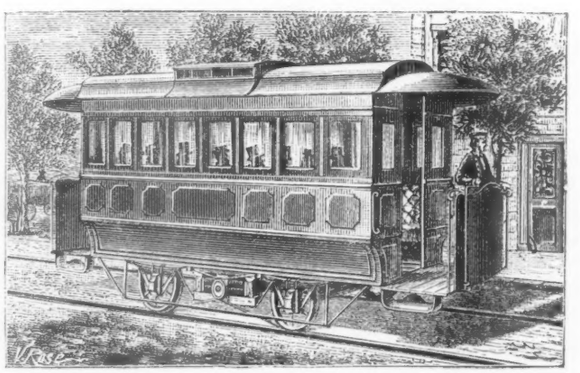

FIG. 2.—ELECTRICAL STREET CAR.

THE ELECTRICAL TRAIN.

The advantages which electricity possesses over steam in railway transit are so apparent, as to be immediately acknowledged when brought to the notice of the intelligent.

As regards the feasibility of the electric railway, we may observe that the system was introduced by Dr. Werner Siemens, of Berlin, and has now been successfully worked without any interruption for nearly two years on a line at Lichtefelde, near Berlin, also at the Lauckerode collieries for mineral traffic, and recently at several other points, as in England and on the continent with gratifying results. The largest application of the principle was effected in the north of Ireland, where Portrush and Bushmills were connected by means of an electric line six miles in length with gradients of one in thirty-eight. So successful did this line prove, that it has recently been extended six miles further, and the power necessary to operate the dynamo, which heretofore was obtained by the use of coal is now collected from a waterfall in the vicinity of one of the termini of the road.

A temporary electric railway was established by the late Dr. C. W. Siemens, at Paris, in connection with the electrical exhibition of 1881, and in this line 95,000 passengers, it is said, were conveyed within the short period of seven weeks. At the recent Vienna exhibition a very successful line of electrical railway was also established, and the Messrs. Siemens have recently taken contracts to build several electrical railways; one of these being an underground road to run between Charing Cross and Waterloo Station in London.

As is well known, there are several descriptions of electric railways. These may be divided into two classes. 1st.—Those which pick up electrical energy from one or both

rails, from a third rail, or take it from a contact-motor running on a suspended rail overhead. 2nd —Those which carry their own power with them in the shape of storage batteries.

This latter is the most unique, the most convenient, and, it is safe to say, the less likely to get out of order. When the cost of insulating or isolating the electric main, and the liability to annoying interferences in a long line are considered, it will be seen that the independent motor system is likely to prove the most efficient

Fig. 1 represents a train in convoy of such a motor; the system being one recently devised under the auspices of the Faure Accumulator Company, in Paris, and soon to be established in the suburbs of Paris.

magnet is drawn toward a piece of iron with a force precisely equal to that with which it draws the iron to itself, and a contemporary of his demonstrated that the same law held good also for the force of electric attraction, an electrified body drawing a non-electrified one to itself, and being itself attracted with an equal and oppositely directed force.

The electric motor is especially adapted for railway purposes. The only motors which can at all compete with the storage battery, are those driven by the expansion of gas which is stored under a tremendous pressure and are thus, as may be imagined, extremely dangerous. The storage battery may be said to po sess no element of danger, its parts are few and easily handled. Therefore it may be said to be unrivalled.

electricity instead of by horses; yet, so ingeniously are the accumulators packed away that the car moves without its means of propulsion being apparent to the eye. The accumulators are packed away under the seats, a space of which in these vehicles usually no use whatever is made. The car, with accumulators, weighs about 4½ tons, and when loaded with forty passengers, there is a total weight of about 1¾ tons on each wheel. A computation made by a good authority puts the daily cost of such a car, not including first cost and wear and tear, at 6s. 3d. (English money) against 26s., the daily cost in England of two horses.

This car moves along noiselessly, and is easily controlled by one man, standing on the

pense of speed in the ratio of about 20 to 1, the motor wheel making 1,200 revolutions per minute when a speed of eight miles an hour is attained.

The secondary battery is carried on a platform below, hung from theframe work. At one side of the rider is a small horizontal disk, called a commutator, resembling somewhat a switchboard in appearance.

By working this, the cells of the battery are turned on or off at will, and, as the full power is attained only by passing through all the intermediate powers, there are no shocks or sudden starts. Supported on rods on either side in a convenient place for reading is an arm-meter for measuring at every moment the main current and a volo-meter for showing the electro-motive force between

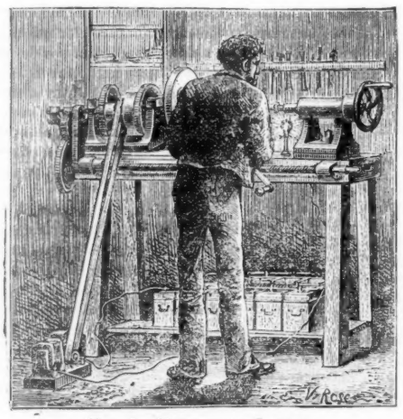

FIG. 8.—ELECTRICAL LATHE.

FIG. 6.—MARINE ELECTRIC LIGHT.

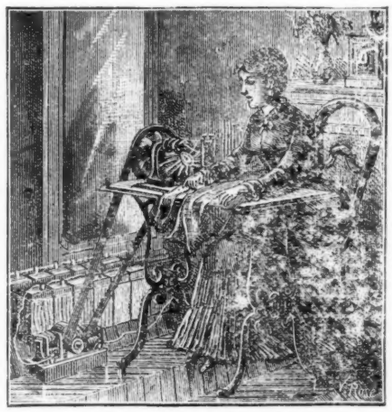

FIG. 5.—ELECTRICAL SEWING MACHINE.

As may be supposed, the leading car is the motor. The accumulators are stored under the seats of this, the current being communicated by insulated wire to a Siemens' dynamo machine. This dynamo is made to act like a motor, and is connected with the axle of the wheel. The power of the accumulators is capable of supplying a constant motive force to the train for seven successive hours. The action of the motor may be reversed at will, and by an ingenious contrivance, the power may readily be increased or

As another evidence of the peculiar fitness of the electric motor for railway service is the fact that the rate of speed at which it may be driven is practically unlimited, being stayed only by reason of air resistance, heated bearings, and friction of machinery.

Singularly enough, though taking up but little room, which is always limited in a railway train, the electric accumulators are very heavy, which heaviness, as we know, is a necessity in a railway motor, in order to furnish its ufficient adhesive force upon the rails.

front platform, as will be seen in the subjoined cut.

Like the electric motor, which pulls the train behind it, the batteries in this street car must be occasionally recharged at convenient stations; a street car can be readily charged to run seven hours, and a motor for a train can be furnished with power for even a longer period, if necessary.

THE ELECTRIC TRICYCLE.

For some time the tricycle has been popu-

the two terminals. Above the arm-meter and volo-meter are two incandescent lamps of four candle power each. These are, of course, generated from the storage battery. The brake and the rack and pinion steering apparatus are of the usual pattern.

The motor employed in this tricycle, weighing forty-five pounds, is, as a matter of fact altogether too powerful for the amount of power required. The battery itself weighs one hundred and fifty pounds, and contains energy equivalent to two one horse-

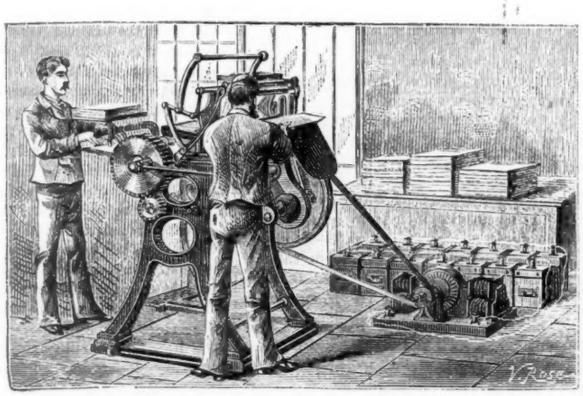

FIG. 7.—ELECTRICAL PRINTING PRESS.

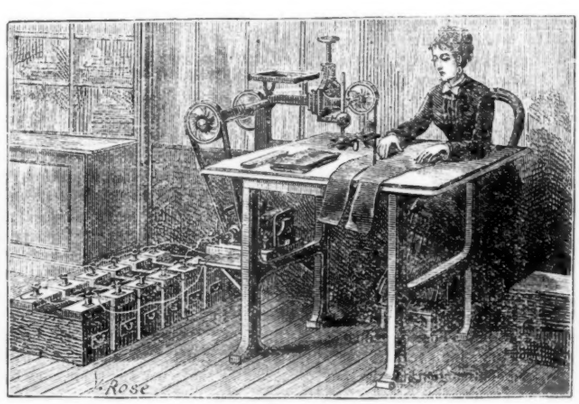

FIG. 4.—ELECTRICAL CUTTING MACHINE.

diminished, by adding to or taking from the number of cells by means of an ordinary electric switch. By breaking the circuit, the motive power is stopped, and the brake being then applied, the car is quickly brought to a stand-still.

The compactness of the secondary battery, its fecundity and its tractability, as one might say, make it peculiarly adaptable to purposes of locomotion. Its further development from the Planté type, due to the genius of Faure, was an astonishment to the scientific world.

The great fundamental principle of mechanical science laid down by Newton, to the effect that to every action there is a contrary and equal reaction, is not limited to the recoil of a gun, or the return of a bent spring, but it is true also of chemical action as the storage battery proves. Newton found that the

A locomotive, for example, must have weight, in order that its wheels shall exert the necessary adhesive force upon the rails; say, about five hundred pounds per ton. In other words, the adhesive power must exceed the tractive force or the wheels would slip. This being the case locomotives are usually from twenty to thirty-five tons, not including tender, and incline engines are about forty-five tons.

The train shown in Fig. 1 is not intended to be run on a main line, for as yet we have not demonstrated the advantages of electricity over steam in long lines of road, but, if the rate of improvement which has obtained during the past two years shall be continued in the future, there is reason to believe that it will be at a no distant day.

ELECTRICAL STREET CAR.

Fig. 2 represents a street car operated by

lar in England and France. Having three wheels, as its name would imply, it is adapted for general use and requires but little skill to manage, being worked by pedals, as is the bicycle.

The Faure Accumulator Company have begun to build tricycles with storage batteries neatly fitted to them, so that all the rider or riders, for they hold two persons usually, have to do is to steer their vehicle, the battery, which is packed under the seat, furnishing the required power to drive the wheels.

Fig. 3 is an accurate illustration of the electrical tricycle. To the side of one of the wheels (44 inches in diameter) is attached a smaller toothed wheel, having 248 teeth; this, geared with a pinion of twelve teeth, is connected directly with the motor itself. The motor, therefore, gains power at the ex-

power hours, or to one horse-power for two hours, or to one-half horse-power for four hours.

ELECTRICAL CUTTING MACHINE.

Fig. 4 represents the storage battery or accumulator driving a cutting machine, thus relieving the operator of the task of working the treadles, a work requiring, especially in a woman, great physical endurance. It is no more fitted for women than plowing or other manual labor. Yet, if it were not for the introduction of this admirable accumulator women would continue to operate these heavy cutting machines at the expense of their healths.

THE ELECTRICAL SEWING MACHINE.

Fig. 5, like Fig. 4, represents a machine, which, though heretofore working with the feet, is made to run without any manual labor whatever.

ELECTRICAL MARINE LIGHT.

In the case of steam vessels with a surplus supply of power, a dynamo of sufficient power to generate good lights, ether head-lights or side-lights can always be worked. On sailing vessels, however, it is another matter. Owners are not likely to put a steam-engine and engineer aboard expressly to supply powerful head or side-lights.

The present condition of the Faure electric accumulator obviates this difficulty. Masters of sailing vessels can put aboard a few electric accumulators, and, without the aid of an engineer, they can obtain powerful head and side lights. There need be no climbing up in the rigging either, every afternoon, to set lamps. The lights can be fixed and all that is required of the master is to turn on the current from the accumulators and the lights are aglow. Only those who have been to sea and are aware of the dangers in thick or dark weather, caused by weak lights, so weak some of them are that the look-out of an approaching ship cannot see them until he has nearly run them down—only such a person can appreciate what a boon a good strong head-light and two side-lights of electricity would be to the mariner.

ELECTRIC PRINTING PRESS.

The small printing press is one of those mechanisims to operate which soon tires a man, and yet does not perform a sufficiently valuable service to warrant the purchase of a steam-engine, and the employment of an engineer.

As will be seen in Fig. 7, the printing machine may readily run by the Faure accumulator. Any man who has sufficient intelligence to be entrusted with a printing machine, can easily handle the apparatus of the electrical accumulator, for it only requires being turned on and off, and a few instructions regarding the regulator.

THE ELECTRICAL LATHE.

In small shops, where the item of coal and the pay of an engineer is seriously felt in the pay account, the electric accumulator will perform a valuable duty. As shown in Fig. 8, it may be connected, by means of belting, with a lathe and thus the engine and engineer may be dispensed with.

A wire coming to the shop from the neighboring electrical station can be made to recharge the accumulator when its power shall have become exhausted. No doubt, the day is not far distant when electrical supply stations will be established in the large cities, and, being connected with all the small work shops and other establishments requiring power, will do a good business in furnishing it. The tricyclist and the owner of the electric-launch also, may, by means of a wire brought down to the river side or the curb-stone, be enabled to obtain, at any time, a new supply of electric energy.

Questionable Methods of Opposing Electric Light Competition in Providence, R. I.

We have from time to time commented on the energy with which the American Electric and Illuminating Company has prosecuted its business of putting Thomson-Houston electric lighting plants into various New England cities, and commended its vigorous methods of dealing with competitors. We have noted the opposition with which it has been met in establishing a plant in Providence, and have informed ourselves as to the facts in the case.

It seems that this company, some months since, leased a building in Providence suitable for an electric light station, equipped it with steel boilers of two hundred horse-power, four Armington & Sims engines of fifty horse-power each, and the necessary dynamos, lamps, and other electrical appliances for a full two hundred light plant, expending in actual cash over sixty thousand dollars in the work, every dollar of which has been paid. Having shown its good faith in this substantial way, it applied to the City Council for authotity to run its wires over a designated route in the city. Its petition was referred to a joint special committee of both branches of the City Council, and on Wednesday of last week, Nov. 21, that committee gave a public hearing, at which the petitioning company and any who desired to oppose the granting of their request were notified to appear. The American Electric and Illuminating Company was represented by Col. Spooner, member of Congress from the Providence district, who urged the granting of the petition, and offered a large number of letters, and the evidence of prominent gentlemen present, as to the character of the light, the responsibility of the company, and its straightforward and business like method of conducting its affairs.

Col. Douglas appeared for the only remonstrant, the Rhode Island Electric Light Company, which has a Weston plant in operation in the city of Providence. He said nothing against the merit of the Thomson-Houston light. He offered nothing against the station which, as we know from disinterested persons in whose judgment we have implicit confidence, is a model of construction and arrangement. He could not raise any question as to possible obligations for damages falling upon the city, because the petitioning company offered to give any desired bond, with surities satisfactory to the city council, holding the city harmless in the event of any damage arising from the introduction of their light. Finding no opportunity for attack in any of these directions, he attacked the personal character of President Goff and other officers of the American Electric and Illuminating Company, on charges long ago exploded and disproven, concerning their connection with the American Electric Light Company, of Massachusetts, a corporation long defunct. The facts in this case have been rehearsed in these columns. Concisely stated, they are that Mr. Goff, by false representations made to him, was induced to become vice-president of this defunct corporation, that he was connected with it just twelve weeks, that at the end of that time he discovered that he and his associates had been duped, that he exposed those who had deceived him, and that, to the last dollar, he expended his private property, amounting to about $40,000 in buying back stock from people who were led to invest in it because of his connection with the company.

Further, as evidence that it was he who was really the victim, we long ago published a letter to Mr. Goff from Mr. Rowland R. Hazard, president of the Gramme Association, which investigated the matter thoroughly. In justice to Mr. Goff, we reproduce it here:

Office of the GRAMME ELECTRIC COMPANY, }
115 Broadway, N. Y., May 9, 1882. }

EDWARD H. GOFF, Boston:

Dear Sir,—I acknowledge receipt of your favor of May 3d on the following day, and beg now to thank you for the very full and satisfactory report which you make of the proceedings of your late associates, which fully confirmed our latest advices and opinions. We have taken the liberty of transmitting copies of your letter to the several constituent companies, and shall take every opportunity in the future, as we have in the past, to expose the business methods of which you are one of the numerous victims. We are looking after several of the companies organized by the same managers, and hope that you may find some responsible person to hold for the pretences which induced your expenditure and service.

Yours very truly,

ROWLAND R. HAZARD, *President.*

It was noted as a singular coincidence that on the morning after the hearing in Providence, there appeared in the *Boston Journal* a special dispatch from Providence, purporting to give a report of the hearing, which was garbled and distorted by omitting nearly all the evidence introduced in favor of the petitioning company, but carefully giving all the false statements made by the counsel for the opposing company in Providence, and so worded as to give the impression to the casual reader that the petitioning company was one and the same with the American Electric Light Company of Massachusetts, a corporation long defunct. And it was further noted that some one was at the pains and expense to send hundreds of copies of this issue of the Boston *Journal*, with the false telegram *marked*, to prominent people in all the cities in New England in which the American Electric and Illuminating Company has or is establishing plants, with the evident purpose and intent to injure it in the eyes of its patrons and friends.

It was to be expected that the competing company would oppose the introduction of the Thomson-Houston lights to compete with its own. Had it confined its efforts to honorable methods, and had the opposition been confined to the city of Providence, where the contest was in progress, there would be no word of criticism from us. But its course of attack was unworthy and dishonorable, because founded on statements long disproven, and its case was weak because based on personal calumny. And the sending of a garbled dispatch and its wide-spread circulation in selected cities *marked*, and addressed *personally* to gentlemen identified with the companies using the Thomson-Houston light, leaves *somebody* in a position so contemptible that it is beneath criticism.

Electric Lighting in Railroad Cars.

It is claimed that the problem of lighting railroad cars by electricity has arrived at a practical solution in England. The "Cheeswright railway electric light" is actually in partial operation on the Great Northern Railway, and carriages are being fitted for it on the Southwestern and Great Eastern and some other lines. It dispenses wholly with steam engine and dynamo for its supply, and depends solely on the old voltaic battery with certain novel combinations of the elements. An exhibition of this system took place last month at the offices of Mr. William Gammon, Manager of the South Wales Department of the London and Southwestern Railway. Six incandescent lamps, of about six candle-power each, were supplied from a battery of nine cells, and they gave an excellent steady light. A number of gentlemen interested in the lighting of railway carriages, which is the leading object of the patentees, were present and expressed decided satisfaction with the steadiness and brightness of the light, and the extreme simplicity of the apparatus. It was stated that eighteen of these lamps, equal to 160 candle-power, suffice for a Pullman car, that the whole weight of the battery would not exceed three and one-half hundredweight, easily carried beneath the vehicle, and that a single charge would last from twenty to twenty-five hours. The current can be switched on and off with ease, so as to light or extinguish all the lamps of a carriage, or, if connected, of a whole train instantaneously. A single installation for a railway carriage would cost from $50 to $60, which is said to be not more than the first cost of gas. It is claimed further by Mr. Zolrab, the engineer in charge of the apparatus, that the elements employed can be sold after they have done duty in the battery as chemical compounds, for as much value as the cost in the first instance, and that the price of working would not be more than that of gas, and for a superior light.

New Mode of Insulating Wires.

M. C. Widemann has communicated a novel mode of insulating telephone wires to the French Academy of Sciences. Having used Nobili & Becquerel's process for coloring metal by baths of plumbates and alkaline ferrates, M. Widemann observed that the colored coating resisted galvanic action. The skins of peroxide of lead or iron served as insulators, like a layer of india-rubber or gutta-percha. The method of preparing the skin is simple, and the cost small. It suffices to prepare a bath of plumbate of potash by dissolving 10 grammes of litharge in a litre of water, to which has been added 200 grammes of caustic potash, and boiling it during half an hour. The mixture is then allowed to rest, is decanted, and is ready for use. The metal wire to be coated is attached to the positive pole of the battery, and, with a small electrode of platinum attached to the negative pole, is plunged in the bath. Metallic lead in a finely divided state is precipitated at the negative plate, and peroxide of lead is deposited on the wire, with all the successive coloration of the spectrum. The insulation is only perfect when the wire has reached its last tint; that is a black brown. A wire thus covered is very highly insulated, and the fact is well worthy the attention of electricians and instrument makers.

A New Mode of Reduction—Electrical Agency Employed.

The invention of Mr. Stephen Henry Emmens, of Soho Square, in the county of Middlesex, actuary, "Improvement in the reduction of the metallic ores," relates to the electrolytical reduction of metals from their ores, and is designed to effect this by the electrolytical decomposition of solutions of the salts of sodium, or other chemically equivalent salts in the presence of such ores.

The ore is prepared for treatment by breaking it down to a coarse powder or other suitable size, according to the nature of the ore; and then calcined with or without the addition of coke, alum, coal, charcoal, or other reducing material; but in some cases this calcination may be omitted without materially interfering with the success of the operation.

After the ore is prepared as above mentioned, it is placed in one compartment of a tank of any suitable material and size, and divided into two compartments by means of a porous diaphragm or partition. Each compartment is further provided with an electrode, or electrodes of carbon are disseminated throughout the ore in order to obtain a greater uniformity of action. The tank is then filled with a solution of sodic chloride, sodic nitrate, or both combined, and the electrodes are connected with the poles of a galvanic battery or dynamo, in such a fashion as to cause an electrical current to flow through the tank, from the ore to the opposite extremity. Nascent chlorine, or nitric acid, or a mixture of the two, is thus evolved in the ore compartment, and acts on the metals contained in the ore and gradually dissolves them, its action being in some cases assisted by a jet of steam, or other source of heat.

At suitable intervals the liquors are drawn off from the two compartments and are mixed together, in which case the metals in solution are precipitated, by means of the alkali derived from the electrolytic decomposition of the original salt; and then the supernatant liquid is ready to be used again for the treatment of a fresh parcel of ore. The ordinary method may be employed if preferred, or the metallic solution may be electrolytically decomposed. Sometimes the ore is put in a porous tank or casing, placed in an outer tank, and sometimes I simply place the ore at the bottom of a tank and fix the negative electrode in the supernatant fluid. In this latter case, which is especially suitable for ores containing gold and silver, Mr. Emmens prefers to place a receiver under the negative electrode, to catch any metallic deposit that may drop away from such electrode; and I furthermore add some potassic cyanide or sodic hyposulphite to be working solution where the extraction of gold or silver is desired. In some cases the preliminary furnace reduction of the ore is carried to the extent of producing a regulus, which is then connected up as an anode in the reduction tank, and proceed as before mentioned. In cases where metallic compounds are formed of a nature to remain wholly or partly undissolved in the tank, the ore is lixiviate with any suitable liquid, in order to remove such compounds.

Solar Potential.

Sir W. Siemens has promulgated the hypothesis that the sun possesses a high electric potential, which possibly produces the phenomenon of the zodiacal light. He accounts for the rise and maintenance of this potential by friction of the matter, which, according to his theory, having been dissociated by the light and heat rays emitted from the sun flows in from cosmical space to its polar

regions. This would, after condensation had set in, again undergo combustion and then flow towards the sun's equator. In doing this it would be electrified by friction with the rotating body of the sun, and then be diffused afresh in cosmical space, in its electrified state, by the centrifugal force of the rotation. If this theory be correct, it follows that the phenomenon is similar to the electrification of the apex of the Egyptian pyramids by the whirling dusts of the desert. As it must be also assumed that the connection extends far beyond the orbits of the planets, the body of the sun must be regarded as having an electrical potential with respect to these, and acting distributively upon them. According to Dr. Werner Siemens, in a recent article in the *Sitzungsherichte der Königlich preussischen Akademie der Kissenschaften zu Berlin*, this supposition of a solar electric potential would explain some puzzling terrestrial phenomena. If true, it follows that the calculated ratios of the masses of the sun and planets to that of the earth would be changed. These alterations would be sensible, especially in the case of the small planets and satellites, since electric force is a function of the surface. The paths of the planets would not be interfered with if electric force were added to gravity, because electric attraction also varies inversely as the square of the distance. The disturbing influences exerted by the planets on each other's path would, on the other hand, be changed, if gravitation were diminished by electric repulsion. Perhaps, says Dr. Siemens, it is reserved for astronomy to prove the existence or non-existence of electric potential on the sun by the perturbations of the path of Mercury.—*Engineering.*

The Vienna Electrical Exhibition.

The Electrical Exposition closed November 3, and it is the general opinion of experts who have attended its sessions that much progress has been made in the field of electrical research and experiment. In the section of the scientific commission, specially occupied with measurements of the work of dynamos, arc and incandescent lamps, etc., the measurements of electrical energy are in the particular charge of the delegate from Portugal, Dr. Antonio dos Santos Biegas, Professor of Philosophy in the University of Coimbra. The commission is also engaged in measurements of motors, boilers, telegraph apparatus, telephones, microphones, etc.

It is reported that the Swan United Electric Light Company will bring several suits against the Edison Company for infringements of Austro-Hungarian patents on incandescent lamps. The Swan people assert that Edison is not the prior inventor of the incandescent lamp.

Prof. A. von Waltenhopen gave, a few evenings since, a popular scientific lecture on magnetism and induction, and Dr. Werner Siemens gave a very interesting address on the electrical locomotive. He declared that the invention is by no means new, as only a quarter of a century after the invention of the voltaic pile it was proposed to use electricity as a motive power. Both steam and electricity are yet imperfectly applied to locomotives, and time alone can perfect their use. In 1878 the first electrical railway was actually built and operated for a coal mine by Siemens & Halske. For long lines of railway, Dr. Siemens says, with heavy trains, electricity can never be used with good results, but for connections between important centers in cities it will be valuable. An electrical railway can be built very cheaply, and it will have the advantages of the absence of smoke, steam and noise in a city. The light cars can run very quietly, and an elevated structure could be built very light and ornamental, and would speedily take the place of horse-cars and omnibuses. Dr. Siemens calculates the cost of running an electrical car at the rate of ten cents for each four miles. The lecture was given in the theater of the Exposition, and all the seats were filled, all the most eminent scientists here being present.

Mr. Herring, of Philadelphia, and Prof. Voit, of Munich, have been making photometric measurements of incandescent lamps. Novelties in the line of incandescent lighting are daily coming in, such as "electric flowers." A winter garden in the central corridor shows a cornflower lighted from an accumulator, a large bouquet lighted by Swan lamps, etc.

Wagner's electrical agioscope, an apparatus for exhibiting photographic views by the electrical light, has attracted much attention.

The Hofrath Stephan, President of the Scientific Commission, gave an interesting address on the 14th, on the work of the commission, alluding to the abandonment of the old system of giving medals, and the substitution of certificates of results. In speaking of the inspection of dynamos, he said that they should be specially examined with reference to work performed; as to the loss of energy by friction and heating, etc. As regards incandescent lamps, he says light and heat are the work performed, but light is the sole result desired. The measurements will be as regards current consumed per horse-power and amount of light estimated in standard candle-power. He showed that the increase of light at a high candle-power is greater than the increase in horse-power. Thus, if .04 horse-power be required to run a 10-candle lamp, only about .08 horse-power is required to run a 50 candle-power lamp. This shows that an incandescent lamp is an economical lighting agent of high candle-power, providing it can stand the current; therefore, it should be the aim of electricians to construct the lamps to that end, and to overcome the difficulties in the way of making lamps of high candle-power. He gave an interesting example of the economy of electric lighting as compared with gas. One horse-power is required to run twenty lamps as they burn in the theater, while a standard gaslight of 15 candle-power consumes in one hour 141 litres of gas, which requires a theoretical power of 1¼ H. P. He says that a large part of the gas is consumed in furnishing dark heat, and only a small part in giving light; in other words, gas heats much more than it illuminates, while the reverse is true of the electric light.

Many accumulators are exhibited, and their operation is being accurately measured, with regard to charging and discharging. Wired motors are also exhibited, with respect to their employment in charging storage batteries, and Mr. DeCalo gave an interesting lecture on this topic a few evenings since. Mr. Fleish Von Marscow lectured on animal electricity, illustrating it with experiments with the nerves of a frog, recalling Galvani's earliest experiments. One of the most interesting of these tests was connecting the nerves with a telephone wire. When harmonious sound waves were passed through the wire, there was no motion of the nerves, but broken waves produced contractions. In connection with this exhibition, Professors Mosebig and Moorhof spoke of the use of electricity in medicine.—*Exchange.*

The Siemens Family.

The late Ferdinand Siemens, of Hanover, had eight sons, of whom five are now living, all of whom are gifted with inventive genius. Under the firm-name of Siemens & Halske has been founded a vast establishment for the application of electricity and magnetism to the industrial arts. Werner established the pneumatic dispatch system in Germany; also the block signal system on railways. Three firms in Berlin, London and St. Petersburg are the common property of the brothers, Werner, William and Carl. There are numerous branch establishments all over Europe,

The London brother, William Siemens, is a joint inventor with Werner of the differential governor for steam engines, and sole inventor of the double-cylinder air pump, and also of a celebrated water meter in use in this country and Europe. His greatest invention, jointly with his brother Frederick, is the regenerative gas furnace. He planned and has built the well-known cable steamer Faraday.

Several Atlantic and other cables were manufactured at the great works of Siemens Brothers at Woolwich, and Carl Siemens laid the direct United States cable. He is not so much of an inventor, but has greatly aided his brothers in extending their inventions. He is at the head of the establishment in St. Petersburg, where is situated the Siemens' large manufactory for telegraph apparatus.

A tall iron lighthouse, sixty feet in circumference, has been erected at the Lighthouse Department station, in Tompkinsville, Staten Island, in which tests will be begun in a few days, of the practicability of using the electric light for lighthouse purposes. It is said that plans have been prepared for a second electric light tower at Hell Gate, which would be placed on the shore opposite the one lately erected there, provided the first one proved a success.

The Daft Motor Tried on a Little Saratoga Railroad.

A peculiarly-shaped, box-like structure, painted a bright red and surmounted by a brass bell, stood on the track of the Saratoga, Mt. McGregor and Lake George Railway at Saratoga yesterday afternoon. It bore on either side in gilded letters the word Ampere. A perpendicular board in front, which resembled in form the dashboard of a heavy farm wagon, was ornamented with two circular registers bearing brass handles, and a series of black-handled stoppers, fitting between surfaces of brass. The driver's seat of this strange vehicle was large enough for only one person, and an iron lever, penetrating the floor, stood perpendicularly beside it. All the machinery was covered from sight. Between the rails of the narrow-gauge track upon which it rested had been laid a third rail insulated from its fastening spikes at each tie by a strip of vulcanized rubber.

At 2½ P. M. fifty gentlemen from New York who had been invited to witness an exhibition of the Daft electric railway motor, arrived. W. J. Arkell, general manager of the railroad, led them to a passenger coach near the end of the triple track. A spare, thin-featured man with fine reddish beard and white eye lashes mounted into the seat of the red-boxed electro-motor. This was Leo Daft, its inventor.

The attention of the crowd was suddenly diverted by the strange actions of horses which happened at the street crossing to step upon the middle rail. One fell flat, and others stumbled and then sprang as if they were struck with a whip. Mr. Daft's employees touched with one hand the center rail and with the other the outer, to show that the current was harmless. Others imitated them. A sharp, tingling sensation in the finger tips was the only result.

Mr. Daft turned a handle, and there was a rattle of iron in the box. He touched another handle, and the motor moved swiftly down to the car. A partial reversal of the lever at his side and the motion was suddenly checked. The buffer of the motor stood three inches higher than that of the car. They were tied together with a rope.

"Now, if half of you gentlemen will get out of the car," shouted a young man, "we will go ahead. This is only a trial test, and you can't expect this little motor to draw such a load."

Nobody left the car. The half dozen who had climbed upon the motor kept their seats.

"It's only a question of the rope breaking," Mr. Daft said, and touched the levers. For an instant there was a harsh squeaking in the box of the motor, the rope straightened, and, starting with a scarcely perceptible motion, the car moved, soon accelerating its speed.

"Our electricity," Mr. Daft said, "is manufactured by a generating machine, operated by a twenty-five horse-power engine in the Gossamer works yonder, a quarter of a mile away. It is passed into the center rail by that insulated wire. It is a low tension electricity, manufactured by my generator. High-pressure electricity would kill horse or man who stepped on the center rail. The wheel underneath the motor takes up the electricity and passes it into the dynamo in the box. The electro magnets are set in motion, and small pulleys communicate the power to the axles by larger pulleys on the latter, and at the same time convey the current to the outer rails and complete the circuit. This motor would draw thirty tons."

ELYRIA, OHIO, Nov. 12th, 1883.

Editor Electrical Review:

Inclosed please find three dollars for one year's subscriptions to the ELECTRICAL REVIEW.

Your journal is very full of interesting matter and keeps up with the advancements in the science. There is quite a disposition for all to dip in and develop something in the way of novelty, etc.; and when they handle free electricity, I notice they do not always stick to the text when *theory comprises* the mass of the *contricance*. There have been two articles in your paper lately, one on lightning rods applied to buildings, and those applied to oil tanks, and I feel that neither contrivance will be found quite adequate in practice. There is a fundamental principle which is not always kept in view in these arrangements, and that is the fact that this form of electricity moves in a line and on the route of least resistance, and that that line is not always by the conductor supplied, but through comparatively a non-conducting substance. The relation of many tanks to a charged cloud is precisely the same as a discharging rod is to the charge inside the jar. As the cloud passes over the tank, the negative element collects it, and pervades the tank, and is conducted to it by its large feed pipes which traverse the country; the tank is the knob, and the pipes or pores the the rod, and unless the superstructure of rods is very ample in conductivity, the tank will get a portion of a discharge from the clouds notwithstanding the rods, and that any charge given to the tanks from a cloud will travel over portions of of the tanks to the feed pipes, and so be lost in the earth through which such pipes travel. Surrounding a tank with lightning rods terminating in the earth, will not prevent the tanks being the conducting factor. All attachments to a tank which terminate in the earth surrounding the tank, are all well in their way, but will not furnish the avenue of escape sought by the electricity. Respectfully yours,

J. L. FINN.

ANSWER:

Mr. Finn's statement in reference to portion of the electricity of a lightning discharge passing over an oil tank and its supply and delivery pipe, notwithstanding the application of lightning conductors around the tank, is correct.

He has, however, not carefully read our article on Spang's radial system of lightning conductors as applied to an oil tank. Mr. Spang provides for the passage of portion of the electricity over the tank and its supply and delivery pipes, and prevents electric arcs or lights being formed between the tanks and pipes, and the radial system of conductors shown and described, by electrically connecting them together, thereby preventing the ignition of gas between the tank and the radial system of conductors.

The following extract from pages 50 and 51 of Spang's recent treatise on Lightning Protection should convince Mr. Finn and others that Mr. Spang fully understands the subject:

"The quantity of electricity contained in a lightning discharge between the clouds and the earth is very great, and, owing to its great expansive action, a portion thereof will invariably flow over the material of the building and its metal pipes, etc.; and if the metal pipes and large or long metal masses about the building are disconnected from the radial system of lightning conductors hereinbefore described, the quantity of electricity flowing between the air-terminal conductors and the said pipes or masses may be sufficient to damage the intervening wood, brick, or other material of poor conductivity about he building, or injure the inmates of the building.

"The greater the number of metallic paths from the top of the building to the earth, the smaller will be the quantity of electricity passing over the wood, brick and stone of the building, which are safe conductors of a limited quantity of the electricity contained in a lightning discharge."—ED.

Telephonic.

The Telephone in Fitchburg, Mass.

The Fitchburg exchange, in this interesting city, was opened on April 1st, 1880, about six months after the consolidation of the American Bell and Western Union interests. It was then under the control of the old New England Telephone Company, and its management has been uniformly successful from the beginning. The present manager, Mr. A. H. Kimball, came into the company in October, 1880, and, after thoroughly mastering the details of the telephone business, took charge of the exchange as manager in March, 1882.

The Fitchburg division, as it is now called, includes Leominster and Lunanburg, with central exchange at Fitchburg, and have in use about eighty miles of wire. The total number of subscribers is 294, with average of four subscribers to a line, and make about 1,000 to 1,200 connections a day. The operating force is, Miss Bertie Abbott and Miss Carrie Barnes (day), and Mr. William Weeks (night) operators. The exchange has always been in the Cogshall & Carpenter block, and is a fine location for the telephone headquarters. Superintendent Kimball has in use an old-style Williams switchboard, to which he has added some improvements and modifications of his own. On the whole, the telephone interests in Fitchburg are booming. A new trunk line is going up, between the exchange here and Leominster, and every effort is being made to cover the field thoroughly.

The Tropical American Company.

It is the intention of this company, if the present business continues, to pay a six per cent. semi-annual dividend hereafter. That the managers can do this there is every reason to suppose. The sales of telephone for the past year were over 2,200 complete sets, and their net profits over all expenditures, for the last six months, would pay a dividend of eight per cent. on their total capitalization, figured at $3 per share, and is a net earning of sixteen per cent. a year.

A Splendid Quarterly Report of the Erie Telephone Company.

The first quarterly report of the Erie Telegraph and Telephone Company, to October 1, has just been made to the president and directors by Messrs. Francis Jewett, Arthur G. Pollard and Horace B. Shattuck, the auditing committee, who find that the company earned from July 1 to October 1, 1⅞ per cent., or at the rate of 7½ per cent. per annum upon $4,800,000 of capital stock outstanding. The report is as follows: Whole number of subscribers, as shown by the official returns of division superintendents, October 1, 1883, 7,221; to July 1, 1883, 5,991; gain for three months, 1,230. Total, October 1, 7,221. Number of exchanges, July 1, 1883, 19; added during three months—Northwest division, 18; Southwest division, 13; Cleveland division, 0. Total added, 31. Total in operation, October 1, 1883, 50. The following is a statement of the condition of the company, showing gross revenues and expenses to October 1, 1883: Assets—Construction, $4,957,164.66; expense account, $57,111.01; dividends, $60,000; notes receivable, $4,400; cash, $28,712.16. Total, $5,107,387.83. Liabilities—Capital stock, $4,800,000; gross revenue, $147,350 31; notes payable, $151,624.02; due from divisions, $8,413.44. Gross revenue to October 1, 1883, $147,350.37. Deduct expense account, $57,111.01; dividends (quarterly 1¼ per cent.), $60,000. Total, $117,111.01. Net surplus to October 1, 1883, $30,289.36.

General Manager Downs of the New England Telephone Company proposes to put in use on all the telephone lines controlled by the Lowell syndicate a device, invented by a gentleman in Texas, by which a time current is connected with the telephones, and enables the user to obtain at any time the exact standard time.

A Bill in Equity Against the American Bell Company.

A bill in equity has been brought in the United States Circuit Court, at Boston, by the Western Union Telegraph Company, the American Speaking Telephone Company, and the Gold and Stock and Harmonic Telegraph companies against the American Bell Telephone Company. The plaintiffs seek for an account under an agreement made with the defendant company. The bill sets forth that a controversy had arisen between the plaintiffs and the defendant as to the rights and powers of each in the business of transmitting messages by telephone, and that this controversy was adjusted November 10, 1879, when an agreement was made between the parties. It is now alleged that the defendant has not kept and performed its obligations under the agreement, but has sought to avoid them, and has failed to pay the plaintiffs the royalties and rentals specified in the agreement, and also the increased royalties or rentals as stipulated, and has otherwise disregarded its obligations. The plaintiffs accordingly ask for an account, and for an injunction from entering into further contracts without the consent of the plaintiffs, by which property shall be accepted by the defendant as royalty or rentals for the granting of licenses for the right to use telephones in the United States during the time the contract previously mentioned shall continue in force. The bill was filed in court on Saturday, the 17th inst. and a subpœna was issued in the usual form, returnable in January.

The growth of the value of the telephone stock invests with some degree of public interest this suit. The Bell company claims that when the Western Union sold its rights and interests in all telephone matters to the Bell Company, the agreement was that in consideration of the transfer, the Western Union Company should receive from the Bell 20 per cent. of all the gross receipts for the telephone rentals and royalties. Per contra, the Western Union claim that the proper interpretation of the agreement should include 20 per cent. of the franchises of stock that the Bell Company receives from licenses; that the receipts from this source properly belong with the renewals and royalties, as a part of the Bell Company's receipts. We are informed that the suit is brought to compel an accounting by the Bell Company of all its receipts since the date of the contract of sale.

A Windsor Man's Telephone Discovery.

THE EXPENSE OF TELEPHONE SERVICE DECREASED—SOME REMARKABLE TESTS—PATENTS APPLIED FOR.

J. W. Tringham, manager of the Windsor telephone exchange, has devised an improvement in the construction of telephone lines which bids fair to revolutionize the cost of telephonic service, and at the same time give an almost perfect system. The improvement consists of insulators, which do away with the glass cups entirely. They are made of common hardwood and are of the same size as the side blocks and cross arm pins now in use. A groove about one-eighth of an inch wide and two or three inches deep is made in the lower end of the blocks, or pins. Into this groove the wire is placed, and is insulated by having a piece of thin rubber, two inches square, laid over it. The wire is held in place by a screw which closes the ends of the grooves, and it is held in place as securely as if fastened in a vice, the rubber keeping it from coming in contact with the wood. This constitutes the whole improvement, and while costing only one-eighth as much as the insulators now used, the

CLEARNESS AND DISTINCTNESS

that results in the use of the telephone is wonderful. A wire has been stretched from Windsor to Tecumseh, ten miles, the new insulators being used, and a *News* reporter at the former place last evening talked with the Tecumseh operator, the conversation being far more distinct than for a few blocks over the ordinary wires. Conversation could be carried on with ease standing four feet away from the transmitter, and a question asked in an ordinary tone of voice by a person twenty feet from the telephone was readily answered by the operator, the reporter who stood by receiving the answer. There was none of the infernal humming caused by induction, that is almost always heard when telephoning. Not a sound marred the clearness of the conversation.

When the line was being built another and even more important improvement was discovered, and in a purely accidental manner. The linemen had been given a hand telephone and were told to test the line when they had a few miles of it strung up. About five miles from Windsor the test was made, and the ease with which the experiment was made had actually

STARTLED THE OPERATORS.

The conversation of the several linemen in the open air was plainly heard in Windsor, they being wholly unconscious of the fact. The cord attached to the hand telephone had simply been fastened to the end of the wire, and the conversation had been heard without the aid of either the transmitter or batteries. The weather at the time was most unfavorable for the experiments, and Mr. Tringham is sanguine that he has an invention that will drive the Blake transmitter to the wall, and reduce the price of telephone from $72 per annum to $10, the price of the hand telephone. He has filed a caveat in the Canadian patent office, and has been in Washington this week to file an application for a patent in the United States.—*Evening News.*

A New Recording Telephone.

The *Pall Mall Gazette* describes a new telephone which Mr. Arthur St. George, an English inventor, has just patented. Supplementary to the telephone itself is a contrivance which will, it is stated, not only record every description of conversation carried on through the instrument, but will reproduce the words at any future time. A circular plate of glass is coated with collodion, and made sensitive as a photographic plate. This is placed in a dark box, in which is a slit to admit a ray of light. In front of the glass is the telephone diaphragm, which, by its vibrations, opens and closes a small shutter, through which a beam of light is constantly passing and imprinting a dark line on the glass. Vibrations of the shutter cause the dark line to vary in thickness, according to the tones of the voice. The glass plate revolves by clockwork, and the conversation, as it leaves the telephone, is recorded on the sensitive plate, the words spoken being fixed as is done in photography. The plate can be brought forward afterward, and when replaced in the machine, and connected with a distant telephone, will, when set in motion, give back the original conversation.

The Brooklyn District Telegraph Company.

At the quarterly meeting of the directors of the Brooklyn District Telegraph Company (limited), held last evening at their executive office, 340 Fulton street, Mr Walter C. Humstone, Superintendent of Western Union Telegraph Company, and Mr. R. J. Kimball, both residents of that city, were elected directors, to fill vacancies in the board.

Sale of a Telegraph Company.

The Postal Telegraph Company has just completed a sale of all its property, franchises, patents, &c., to the Postal Telegraph and Cable Company, of which H. C. Gardiner is president, for the sum of $10,000,000. The Postal Company had already completed a working line of telegraph, under its new system, and the new company that has succeeded to its property and franchises expects to have the line extended and in operation by February 1 next to St. Louis, Pittsburgh, Buffalo, and Washington. In two years from this date, the president of the company, Judge Gardiner, says its officers expect to have completed and in operation telegraph lines to all the principal cities in the United States including San Francisco, Portland, Oregon, and New Orleans, besides a new Atlantic cable to Europe and a cable to Brazil. It is contemplated that the company will use the new Atlantic cable now being constructed by James Gordon Bennett and Mr. Mackey, the California millionaire. If a combination cannot be made with them, the Postal Telegraph and Cable Company will construct an Atlantic cable of its own. The tariff of charges by the new company will be 25 cents for twenty words, to all points in the United States, without regard to distance.

The Main Telegraph Office in Paris.

The following extract from *La Lumiere Electrique*, will give a few details about the main office in Paris, which has been rebuilt within a year:

The building, which is located on the Rue de Grenelle, has three floors besides the basement, and presents a very neat, imposing appearance. The basement is reserved for the batteries and steam engines. There are three boilers and three steam engines, two of thirty and one of sixty horse-power. One of the smaller engines is used for pumping water to actuate the small water-motors used to run the Hughes' printing telegraphs, as will be seen further, and the other is used for driving the nine electric generators, whose currents are used to maintain thirty-six Cance arc lamps, which produce the general illumination of the building. The third or largest engine is to be used only in case of damage or derangement to either of the first two. That portion of the basement which contains the batteries constitutes a handsome battery room.

The ground floor is divided off into various compartments for offices, store-rooms, cloak-rooms, dress-rooms, etc. The next floor or *entresol* contains the "ladies' operating-room," as it is called. This operating-room is, in fact, occupied by ladies only, and it contains 196 Morse sets and thirty Hughes' printing apparatus. Of these 206 different sets 92 are used on city lines and for city offices; the others connect the main office with the suburbs and certain of the neighboring cities and towns. Fig. 2 shows a portion of this room which contains the city lines. It also shows the switch-board, or square box-shaped arrangement, on the sides of which the wires are disposed in circular, rosette fashion, radiating from a central circle. The total number of wires is 480, and their combined length from this point to the tables where they are accommodated, is 21.5 kilometers. The form of switch-board has been preserved in preference to any on account of its convenience in making connections and in making changes.

It looks rather primitive and crude to the operator in a large American office, but it must be remembered that the routine there is very different from that followed here. In this country a switch-board affords the facilities for connecting any table to any line, we might say, even though such a large "compass" of changes is not necessary in practice; but in the Paris office there is more permanency in the connections, each set of apparatus being usually reserved for its line or lines. The ceiling being lower than in the main operating room on the next floor above, the light from the arc lamps is projected to the ceiling, and the general illumination of the room is thus obtained by diffusion. Gas is used, however, at each table, or at sufficient distance between the lights to give each operator good light.

The Hughes' printing telegraph comprises a clockwork mechanism, which is ordinarily run by a weight. Of course with women to operate these sets, as in this case, it was out of the question to require them to "rewind the clock" every ten minutes or so, when the apparatus is in continuous use, because the task of thus raising a forty-pound

weight about two feet every ten minutes would be rather vigorous exercise, even for a robust man, leaving out of question the delay and inconvenience of the operation. Consequently another means of producing motion had to be resorted to. M. Humblot introduced for the purpose a small turbine, or water motor, which was operated by the pressure of water in the city mains. These small turbines were very small, scarcely four inches in diameter, but their general introduction under the circumstances would have entailed a wasteful expenditure of water, to which the municipal authorities, if nobody else, would object. Instead of employing city water pressure for the purpose, an artificial pressure is maintained by compression pumps operated by the thirty horse-power engine above mentioned. The pressure is maintained at about five atmospheres. The water passes through the motors and returns to the receiver whence it started below, and here it is again pumped up to give the pressure required to the motor as before. Thus the same water is constantly used over and over again. There are 140 of these small turbines (the greater portion being used for instruments in the main operating rooms), each corresponding to a Hughes' instrument, and the work of pumping the water in the three pumps used to supply them, probably does not exceed fifteen horse-power. A special means of regulating the speed of the turbines is used, so that the working of the Hughes' instrument is maintained constant and regular. The multiplying wheels of the clockwork mechanism could of course be dispensed with, but they are still preserved, so that in case the turbine motors should fail the weight could be rewound and motion obtained by means of it as before.

The main operating room occupies the whole of the third floor of the new building, and also of the annex building, erected in 1877. Fig. 3 represents the new part, which contains more Hughes instruments, a Meyer quadruple and a Wheatstone, the latter in direct communication with Frederica (Denmark), a distance of 377 kilometers, with a repeater at Calais.

The instruments are placed on long tables, arranged parallel to each other in two rows, with a broad aisle between them. The switch-boards are placed in a compartment behind the rear partition, where a space is also reserved for a testing-room.

Pushing Telegraph Enterprise.

J. W. Converse, of Boston, and F. H. May and G. S. Mott, of this city, were yesterday elected directors of the American Rapid Telegraph Company. The old board comprised five members, but in consequence of the close relations existing between the Rapid and the Bankers' and Merchants' Telegraph Company it was thought best to decrease the number of directors of the former company. Nearly ten thousand shares of stock were voted. The newly-elected directors immediately organized, re-elected J. W. Converse president, and made J. C. Case secretary and treasurer, which offices he holds in the Bankers' and Merchants' and Southern Telegraph companies. The combined organizations are steadily pushing their lines Southward. A new four-wire line was opened to Augusta, Ga., on Tuesday, and similar lines will be in operation between here and Charleston and Savannah this week. It is expected that the lines will be extended to New Orleans before Christmas.

A Scientific Skeptic Suggests Some Underground Conundrums.

About eighteen months ago an article from the writer, entitled "Electric Jobs," was published in the *Times*. At that time one of the electric job companies had laid a number of tin tubes in some pitch along Market street, and their stock was selling fast, but the supply was unlimited. The next day after this article appeared, the *Times*, having investigated the affairs of this company and found much crookedness, publicly exposed the same. This caused the stock to drop immediately from $1.50 to forty cents per share. It now sells for five cents per share. It is to be regretted that the shares are quoted below six cents, as they might be used for car fare.

The article printed some time ago commenced as follows:

I have read the notice in to-day's *Times* of the organization of another electric cable company, capital $1,000,000. This is the fifth company, to my knowledge, that has been organized in Philadelphia, with a capital of from $500,000 to $3,000,000, within the past two or three years, for the purpose of either laying or selling electric cables. One company has actually laid some tin tubes in ground and pulled through one of the tubes some gutta-percha covered wires, and messages have been telephoned and telegraphed through the wires to everybody's satisfaction. The demonstration of this fact, at a cost of about $5,000, has put the company or ground-floor men in a flourishing condition, they having been able to sell nearly $3,000,000 of stock. Of course, as soon as all the stock is disposed of at satisfactory figures, this company will then retire happy and allow some others to start, or start themselves a new, grander, nobler and more enterprising company, and sell correspondingly more stock. Another electrical company, with a long list of directors, has obtained a patent for an air tight socket or joint for an iron tube. As they have sold considerable stock, the company can be quoted as doing well and making money.

At the present time an electrical company is laying a large iron trough or conduit made up of short pieces, which the company call sections, on Chestnut street, between Ninth and Eleventh streets. They are also pulling through the conduit some very nice gutta-percha-covered electric light wires, some also covered outside with lead.

This conduit company claim as their invention the iron trough or conduit. Why? Not because it is new. Not because it is air-tight or water-tight. Not because it is light and portable—one hundred pounds to the foot. Not because it is easily or quickly laid—thirty men working ten days, day and night, to lay a block. Not because the plant is cheap or indestructible. Not because it makes a hole through the ground—all pipes, troughs or conduits do that. Not because they fasten the sections and joints together with putty. Then why?

In London the government telegraphs have laid air-tight iron tubes and filled them with gutta-percha-covered wires, but the cost of these wires is enough to prohibit their use as far as the telephone companies are concerned. This Chestnut street conduit system will cost four times as much. Who is to pay for it?

Perhaps after this company has laid a block or so of this conduit and again demonstrated to the incredulous public how electric light, telegraph and telephone wires can be worked underground with no induction, there may be some stock for sale.

What became of the Market street conduit company? One year from now the writer will ask the *Times*, the public, and the lambs, what has become of the Chestnut street conduit company?—J. R., in *Philadelphia Times*.

Description of an Electric Signal Clock.

This instrument is designed—1st. To give the same kind of signal at any regular or irregular intervals; and, 2d, to strike any code of warning and departure-signals for railway trains or street cars, according to the time-table, and for all other purposes where any sort of time signals are required.

It contains certain peculiar features, which operate in the manner described below:

An electro-magnet is connected by wires to a standard clock which closes an electric circuit once each minute. This magnet, by means of a lever and a pawl rotates a ratchet-wheel of sixty teeth one step each minute. The wheel is rigidly attached to the axis of a vertical cylinder, fourteen inches high and six inches diameter, which revolves with it, and therefore makes a complete revolution once in an hour. The cylinder has two divisions, each of which is provided with a hole for every minute of twenty-four hours, or one thousand four hundred and forty holes in all, arranged in a single spiral. A toothed wheel on the axis of this cylinder gearing into another of equal size, imparts motion to a coarse-threaded screw, which raises at a rate uniform with the movement of the cylinder, a small shoe or follower, consisting of a short lever with two arms, the forward end of which passes very near the surface of the cylinder. The rear end of this lever is forked, and gives a lateral movement to an elongated crank and by means, presently to be explained, also to a vertical rocking shaft bearing at its upper end a horizontal bar, adapted to alternately engage with and release stop pins in a circuit wheel. Whenever the vertical shaft is slightly rotated, the circuit wheel (which is driven by a coiled spring) is released and revolves a short distance.

For railway purposes, two signals are usually required for every train, a warning or preliminary signal, which precedes the other by a certain interval, two, three, or five minutes, and a final or departure signal, sounded at the exact moment when the train should start.

Short pins are inserted in the holes in the cylinder which correspond in location to the times of all these signals, the lower division being arranged according to the week day time-table, and the upper one according to the Sunday time-table.

The shoe, or follower, passes over every hole in the cylinder once in twenty-four hours. When, in the course of its traverse, it comes in contact with the first of two pins for any train, the end is moved away from the cylinder a short distance, and by a small rotation of the vertical shaft deflects the horizontal bar far enough to allow a pin to pass and set the circuit wheel in motion. This wheel has upon its circumference a series of projections, which come in contact with a fixed spring when the wheel revolves.

The projections and spring close an electric circuit through the signal bells, a certain number of times, depending on the signal to be given. When the follower comes in contact with the pin, denoting the time of the second or departure signal, the operation is repeated, except that there are a different number of projections on the circuit wheel, and so a different number of strokes upon the bells, corresponding to the distinctive character of this final signal.

When the time of the next train approaches, the same movements are repeated, and so on through the schedule.

At midnight the follower has completed its traverse of all the holes in the cylinder, whether provided with pins or not, and it is then automatically detached from the screw by a cam not shown, and falls freely to a position opposite the first hole in the series, where it becomes again attached to the screw and begins a new day.

A second follower, also connected with an elongated crank, moves in like manner over the upper part of the cylinder, but it cannot put in motion the striking mechanism during a week day. On Sunday, however, it is rendered operative and the lower one inoperative, in the following manner:

Each of the elongated cranks, before described, is attached to a sleeve fitting loosely on the rod, carrying the horizontal detent bar. It communicates motion to this rod by means of a slot in the sleeve, engaging with a pin running transversely through the middle of the rod, in such a manner that a slight movement downward of both sleeves will disengage the lower one from the rod, and the pin will engage with a slot in the upper sleeve, which can then rotate the rod and detent bar against which the stop-pins rest, while the lower one can only turn freely about the rod without affecting the mechanism in any way.

The weight of the sleeves is carried by a cam attached to a ratchet-wheel of seven teeth, which revolves around the vertical rod as an axis. In the descent of the follower at midnight, each day, it moves this seven-toothed *ratchet* wheel and cam forward one space. One-seventh of the circumference of the cam is depressed considerably below the level of the remainder, which is horizontal. The sleeves are supported by a pin in the lower one, which, during six days of each week, rides up on the horizontal surface of the cam, but at midnight, Saturday, it falls into the recess, lowering the sleeves, and thereby disconnects the lower one from the vertical rod and bar, which control the striking mechanism, and engages the upper one.

For this day then the pins in the upper division of the cylinder, corresponding to the Sunday time-table, operate the bells, and those for week day time have no effect. With the next transfer of the follower, at midnight, Sunday, the pin is lifted out of the recess in the cam, and the week day time-table is resumed.

These operations are repeated week after week, requiring no other attention than the winding of the spring which drives the circuit wheel, once a week, or at longer intervals, according to the number of trains in the schedule.

One or two special features of this machine should be mentioned. Instead of the usual arrangement of a stationary magnet and a movable armature, the magnet which rotates the cylinder is pivoted on a vertical axis near the base of the coils (which are in a vertical plane), and the armature is stationary. The poles of the magnet and the armature, both have curved surfaces, which are arranged eccentrically to each other, in such a manner that the movement of the magnet, when the current passes, brings it constantly nearer to but never in contact with the armature. Its path is limited by a stop, and when the electric circuit, through the coils of the magnet, is broken, a retractile spring returns to its first position.

The cylinder is prevented from moving backwards by a fixed pawl engaging with the teeth of the ratchet-wheel, and from giving more than one space at a time, by a wedge-shaped projection on the pawl, which rotates the cylinder, coming in contact with a stop at each movement and preventing further motion of the wheel.

The operation of changing the time-table for a new schedule consists only in removing the pins, which are screwed in, and placing them in new holes. The holes are numbered every five minutes to facilitate this operation.

The code of signals may also be easily changed for one of a different number of blows in the series, by simply substituting for the circuit wheel another with a different number of projections. Three or more signals may be given for each train, instead of two, by proper arrangement of the projections on the circuit wheel and corresponding limits of motion by the stop-pins.

There are no delicate parts to get out of order, or nice adjustments to be made. The wear is exceedingly slight, and the parts are all accessible for repairs, should any such be necessary. The loosening of a single screw permits the cylinder to be removed, and a second one allows the ratchet to come off. One screw holds the magnet in place, and by the removal of two the clock-work, which runs the circuit wheel, is detached.

The patents on this time system are owned by the Electric-Industrial Company, of Boston, whose offices are at 63 Kilby street. Mr. Aaron Blodgett is the general manager of the company, to whom all communications should be addressed. Mr. Geo. W. Blodgett is electrician for the Boston and Albany Railroad, and has complete charge of the electrical department between Boston and Albany.

This remarkably fine time system is in successful operation on the railroad above mentioned; on the Boston and Providence; New York and New England; Eastern; Fitchburg; Chicago, Rock Island, and Pacific; Chicago and Boston railroads. The Boston Postoffice uses this system for the closure of the mails, and several more railways in Boston.

Germany has five hundred mills for the manufacture of wood pulp, and such a degree of perfection has been reached in its manufacture that even for the better qualities of paper it is a complete substitute for rags. Wood pulp constitutes 75 per cent. of the paper stock used in that country.

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CONTENTS.

	PAGE
The Storage Battery in Practical Use	1, 2, 3
Questionable Methods of Opposing Electric Light Competition in Providence	4
The Electrical Exhibition	4
New Mode of Insulating Wires	4
A New Mode of Reduction	4
Electrical News	4, 5
The Government and the Telegraph	8
Electricity on the Coast	8
Book Reviews	9
Telephonic News	6, 7
Telegraphic "	7
New Electrical Patents, &c	10

The Government and the Telegraph.

Under this title we some time since reviewed the arguments put forth in favor of Government control of the telegraph. We said at that time that a careful and unprejudiced review of the question would, in our opinion, convince any intelligent person, that, under a republican form of government, at least, the telegraph was safest in the hands of the people and altogether free from political influences. Further than this we said that, as the theory of popular government was to keep the numerical strength of the office-holding class at a minimum, it was the policy of the government to rather seek to curtail its present force of employes than to look to a farther and stupendous accession to it; that a telegraph under government control would, in all likelihood, be employed for partisan purposes, and its army of political appointees threaten to oppose, if it did not absolutely thwart the will of the people who are sovereign.

In the current number of the *North American Review*, Dr. Norvin Green, president of the Western Union Telegraph Company, in an interesting and exhaustive paper, traversed the same points corroborating what we said, and bringing a mass of testimony to sustain it.

Dr. Green shows that the argument which has from time to time been brought forward, that foreign governments control the telegraph, and that, therefore, we should do the same, has little to commend it. It is a mistaken idea that the public is better served by the government than by private parties.

So far from this being the case, the extent of the lines is very much less in Europe than here, the service is by no means so rapid and accurate, and the tolls are much larger. In support of this let us look at the statistics, as compiled by Dr. Green.

The mileage of telegraph lines in the four principal countries in Europe as compared to the United States is:

In Great Britain	23,000 miles
" Germany	41,000 "
" France	36,000 "
" Austria and Hungary	30,000 "
" the United States	180,000 "

"It will be seen," says Dr. Green, "that there have been established in the United States, by private enterprise, about fifty thousand miles of telegraph lines in excess of the aggregate mileage in all these great European countries. On the lines of the United States there are about 500,000 miles of wire, which is believed to be as greatly in excess of that in the countries named as the excess in mileage of lines. The population of the four countries named aggregates about 150,000,000, and that of the United States is about 52,000,000. While there is, therefore, an average of less than one mile of line for each 1,000 of population in Europe, the people of this country have nearly a mile of line for each 300, and nearly a mile of wire for each 100 inhabitants."

The grants of power under which, it has been assumed the government may take control of the telegraph, must be read in the light of the following restraining articles, section 8, or article I, amendments to the Federal constitution:

"To establish post-offices and post-roads. To regulate commerce with foreign nations and among the several States, and with Indian tribes."

If the power is assumed under the postal grant, then, in the opinion of Dr. Green, the most the government can do is to hire the transmission of messages taken at and delivered from the post-offices, as it hires the carrying of mails, by contract on the best terms it can make. The government does not carry the mails. It hires others to carry them, and has always done so. It has never claimed the power to build or own railroads, or steam-boats, or even stage coaches, or to appoint employes for their operations, to carry on the postal service. But it is now assumed that the government may build or own a telegraph, equip it for operation, and employ a numerous staff of officers and agents for its commercial service, thus exercising powers, says Dr. Green, which no one has ever claimed that it possesses in respect to the postal service.

There were many persons a hundred years ago who thought the government should own the stage coaches which carried the mails—there were no railroads and steamboats then—just as there are persons now who think the government should own the telegraph. But the coaches carried passengers, and it was foreign to the spirit of the Constitution for the State to go into the passenger traffic.

The telegraph, as Dr. Green very truly says, is not a postal service, it carries neither sealed packages nor original communications. Nor is it in general use among the people. Dr. Green says that though there are 52,000,000 people in the country, there are not a half million who use the telegraph.

But let us look at the relative efficiency of a telegraph managed by the State, and by corporate bodies.

Mr. Hueston, for many years connected with the telegraph service of the New York Associated Press, and who Dr. Green says has probably sent and received more telegrams than any other patron of the business, says:

"Commercial messages of ordinary length, in the busy part of the day, are about two hours between Paris and London offices, exclusive of time of delivery. Between Antwerp, or Brussels and London, about the same delay. Between Bremen and Hamburg and London, the time is about one hour. These are short and mostly single circuits, the delay arising entirely from meagerness of facilities. The average time between New York and London is far quicker than between Paris and London. A week's business, taken at random from messages transmitted by day and by night, yields the following results, the time in every case being the difference between time of filing and time of receipt on the instrument in London: Twenty-three messages from Rome average two hours and forty-three minutes; thirteen messages from St. Petersburg average one hour and fifty-six minutes; twelve messages from Vienna average one hour and forty-six minutes; seven messages from Brussels average one hour and ten minutes; thirty messages from Berlin average one hour and seven minutes; fifty eight messages from Paris average one hour and one minute; thirteen messages from Amsterdam average fifty-six minutes. Telegrams from Constantinople average about four hours; from Madrid, take from one to five hours. The messages on which the averages are struck do not vary much from a total of forty words.

What a storm would be raised in this country if people were called upon to tolerate such slovenly service as this! Instead of such waits, the time required for the transmission of messages between great commercial centers of this country has been reduced, says Dr. Green, to from one to four minutes; and between the great produce exchanges and boards of trade to fractions of one minute.

Again, the government is slow to introduce improvements in its line. As a proof of this, all the improvements that have been made in telegraphy in the last thirteen years have been made in this country, where the telegraph is under corporate management.

There is a popular fallacy that European rates for service are much less than here. The contrary is the case, says Dr. Green. The minimum rate of one shilling in Great Britain, and a sum in other European States equal to about twenty-five cents of our money, for messages between all points within each country, carries, he says, a very small volume of business a distance not much greater than it can be transmitted here at as low a rate. But there is, he says, a considerable telegraph business done in this country at a ten-cent rate, and a larger amount at a rate of fifteen cents; while for long distances the rates in this country are very much lower than in any part of Europe. The following table exhibits the rates per word from London to the several countries enumerated:

Austria	700	miles,	9	cents per word.
Belgium	200	"	4	" "
Denmark	500	"	8	" "
France	200	"	5	" "
Germany	500	"	6	" "
Holland	200	"	6	" "
Italy	800	"	10	" "
Norway	700	"	8	" "
Roumania	1,200	"	10	" "
Russia, in Europe	1,400	"	18	" "
Switzerland	400	"	8	" "
	6,800		92	

Paris is about the same distance from London that Boston is from New York. We charge, says Dr. Green, for a message between New York and Boston, and all points in New England, twenty-five cents, which message, with date, address, and signature free, averages seventeen words. A like message between London and Paris would cost eighty-five cents. Vienna is about the same distance from London as Chicago from New York, between which latter points, says Dr. Green, our rate is fifty cents. From London to Vienna a like message would be $1.53. St. Petersburg is about the same distance from London as Omaha is from New York. The rate is $3.06, against our rate of seventy-five cents.

One of the favorite arguments used by those in favor of government control, is that it would bring all the telegraphs in the country under one management. Yet, singularly enough, it has been complained of the Western Union that it has united the major part of the telegraph system under one direction.

Electricity on the Coast.

The lighthouse board, which is under the Treasury Department, is about to make some experiments in sea-coast lighting with electricity (Voltaic arc system).

We congratulate the board upon awakening, though somewhat late, to the advantages of electricity in light towers and beacons. There are those, however, who will be somewhat surprised to learn that the government proposes to make a long and costly series of experiments of this nature on its own hook.

It can, of course, be no secret to the lighthouse board that the French coast has been lighted with electricity for several years, and that the English are now beginning to perfect a like system. Surely the elaborate series of experiments made with electrical lighting on the sea coast by the French naval authorities, may safely be referred to for all the data necessary for the consideration of the subject before beginning its work of establishment. The best it can hope to do is but to confirm the conclusions arrived at by the members of the commission appointed by the French government, a decade ago, to make the experiments. For our government is not likely to make so liberal an appropriation for this purpose as did that of France, and hence the results of the limited number of observations which our board is likely to make could not reasonably be used to refute or contradict statistics compiled not only from a long series of experiments, but with a practical experience of several years. The French and English experiments showed that in foggy and thick weather the same intensity of the electric light, which is white, could not be distinguished as far as the same amount of oil light, which is yellow; but they showed also that a far greater intensity could be obtained at very much less cost with the electric light than with any other kind, and that in moonless nights the same intensity of electric light could be seen farther than the same intensity of other lights.

Again, these experiments showed that, for the cost of the ordinary coast lights, electricity could be supplied of a sufficient luminosity to so light up a harbor as to permit a ship to make the entrance in the darkest night. In case of a storm threatening, this, in itself, is of the utmost importance.

BOOK REVIEWS.

Electricity in Theory and Practice, or the Elements of Electrical Engineering.

By Lieut. Bradley A. Fiske, U. S. N.

New York: D. Van Nostrand, Publisher.

We are constantly in the receipt of letters from all parts of the country asking us to explain the theory of this or that application of electricity. Many of these come from persons whom we would really like to accommodate. Unfortunately for us, however, there are but seven days, of which one is usually looked upon as a day of rest, and the space of a newspaper, like the duration of human existence, is limited. We are, therefore, not always able to satisfy those who are, perhaps, not inclined to be pleased, since we are not always able to satisfy ourselves.

This being the case, we were not a little gratified, as we turned from page to page of a recent production, in which the theory and practice of electrical engineering go, as one might say, hand-in-hand, and where neither are administered *ad nauseam*. Its author, Mr. Bradley Fiske, is a conscientious, able workman, and we cordially recommend his work to the attention of the multitude of ambitious and ingenious electricians and amateurs throughout the country, who are not so fortunate as to possess a theoretical education.

Like many objects which are shown us as evidences of the handiwork of remote ages, the theories, which from time to time are presented to us, as explanatory of certain natural laws, are apt to mislead us, unless we have confidence in those who introduce them.

There are those who form theories before the evidence is all in, and having once made up their minds are wont to look upon the very evidence, which should have served to set them right, as a corroboration of the fallacy which they have adopted as the truth. The evil done by such persons is incalculable; it misleads the unskilled, casts a doubt upon the work of intelligent thinkers, and adds still further to the number, already very large, of inaccurate text-books.

Judging from the work before us, the author is one of those men, unhappily somewhat rare, who are by no means quick to accept theories unless well sustained, and only then after careful examination. The caution and lack of precipitation, which is evinced where dangerous ground is trodden, is at once his best recommendation and the student's safeguard.

A portion of the work is, as its title indicates, rudimentary; but we think it all the more valuable on that account. Those who have experience with electricians and mechanics are aware how inaccurate is the technical information many of these possess, and need not be told that some of them know little of the theory of their work. Such persons have here in compact form and regular order a large amount of theoretical information concerning the most recent electrical work of the day.

We have heard professors in the colleges hereabouts expatiate for hours upon electrical themes of the last century, whilst the major portion of their audience sunk into pleasant slumbers, and the lesser went out to sleep under the trees where it was cooler. Had they had such a book as this before them, they could have so interested their audience, that it would have been very glad to remain awake.

If you want to go through any of the old and white-haired electrical tricks with amber and gutta-percha and friction machines, and frogs' legs, etc., you needn't look in this book. It is devoted to other purposes. Again, we have seen some books, containing valuable information too, such as the "Linear Algebra," and the like, which, to a certain extent fail of their object because they are not sufficiently explanatory and clear. A man who has made mathematics a life's study, and talking to another with a similar contempt for life's objects, may not unreasonably begin in the middle of a complex explanation with the remark "It is obvious that the *n*th power" of so and so is equal to so and so; but when he is addressing a miscellaneous audience, composed of but indifferent mathematicians, he should know that the computation is obvious only to himself.

Fortunately for the reader, Mr. Fiske has not the bad habit of presupposing in his auditor an experienced and skillful electrician; but takes the trouble to explain the theory carefully and lucidly as he goes along, and one has not to read far to discover that he is thoroughly familiar with that which he essays to describe.

Passing over the more elementary chapters in which magnetism, frictional electricity, work and potential voltaic batteries, and the laws of currents are dwelt upon, we come to a chapter on secondary or storage batteries, in the explanation of which we could have wished the author had devoted more space. For the possibilities of the secondary battery are very great; many able men are devoting themselves toward lessening their defects, and the small successes which from time to time are recorded, would indicate that the secondary battery of to-day bears about as much resemblance to the future secondary battery as the bladder which Dr. Clayton used as a gas-holder in 1688 does to the gasometer of city gas works, or as James Watt's crude engine does to the Atlantic steamer.

We are not surprised to find that Mr. Fiske devotes much space to that very important and often neglected department of electrical science, measurement. Nor are we surprised to find that he treats the subject skillfully. We have, if we are not very much mistaken, seen some work of this kind before in "Van Nostrand's Engineering Magazine," which had his name appended; work which, if Mr. Fiske is, as we suppose, commencing his career, promises a position in that part of the profession which in this country has never yet been known to be crowded, viz.: the top. So far as we could see, the author makes no attempt to devise new methods of measurement, but wisely contents himself with giving clearly and succinctly the theories upon which those in vogue are founded.

While there is absolutely nothing new in the author's "Measurement of Electrical Resistance," we do not remember ever to have seen the measurement so clearly demonstrated in so few words, and, where a tangent or sine galvanometer is used his explanatory formulae, considering how complex they might have been made, are models of neatness.

"Knowing from Ohm's law that the strength of current in a circuit is inversely proportional to the resistance," says the author, "we can measure the resistance of any conductor in the following way: Put the conductor in circuit with a battery and a galvanometer, and note the deflection of the pointer. Then remove the conductor, and substitute in its place wires whose resistance is known, until one is found through which the battery produces the same deflection as through the other. The resistance of this wire must clearly be equal to that of the conductor.

2nd. If a tangent or a sine galvanometer is used it will not be necessary to find a wire through which the battery will produce the same deflection; because as the tangents (or sines as the case may be) of angles of deflection are proportional to the strength of current, and as the strength is inversely proportional to the resistance,

$$\tan.\ a : \tan.\ a' = r' : r,$$

$$r = \frac{\tan.\ a' \times r'}{\tan.\ a}$$

or,

$$\sin.\ a : \sin.\ a' = r' : r,$$

$$r = \frac{\sin.\ a' \times r'}{\sin.\ a}$$

in which r is the resistance sought and r' the resistance known.

3rd. With a differential galvanometer, the operation is simplified. In using this instrument, it is only necessary to insert the unknown resistance in the circuit of one coil, and a number of known resistances in the circuit of the other. As the coils are similar in all respects the needle will obey the stronger current, *i.e.*, that in the branch containing the least resistance. Insert now known resistances until the needle gives no deflection when the circuit, closing key is pressed. The currents in both coils must now be equal; in other words, the resistances in both branches must be equal, so that the resistance sought is equal to the known resistance introduced."

A very interesting chapter on the telephone is thus introduced by the author:

"It was while experimenting upon harmonic telegraphy that Alexander Graham Bell and Elisha Gray discovered the principle by which human speech may be electrically transmitted, and invented an instrument for applying that principle." Then follows a short notice under the heading Reis's Musical Telephone; and, as we shall have something to say about this, we will reproduce the first paragraph:

"Before Bell produced an apparatus capable of transmitting speech, however, an intermediate step was taken by Philipp Reis, of Germany. It will be remembered that, to transmit messages on the harmonic system, a number of reeds are used, each one capable of transmitting a note of one pitch, but no other notes; so that to transmit a tune on this system it would be necessary to employ as many reeds as there are notes in the tune to be transmitted. Philipp Reis accomplished the transmission of tunes by his 'musical telephone'—a simple device in which a great number of reeds were replaced by a membrane fixed at all points of its circumference." The author then goes on to describe the theory of Reis's telephone, following this by Bell's Theories, the Edison Transmitter, etc.

The impression this is likely to leave on the mind of the amateur, and these who have, perhaps, had neither the time nor the inclination to look into the matter, is that Reis discovered only the germ of an invention, yet this the author, we feel sure, will admit, is far from the fact. Reis's was more than a "musical telephone." Both Edison and Bell have admitted that they were familiar with Reis's work, and, so far as the transmission of intelligible sounds is concerned, it is more than doubtful if posterity will throw aside the claims of "the poor teacher," Reis, for those of either of the rival claimants.

No better evidence of the efficiency of Reis's telephone could be had than that contained in his letter to Mr. Ladd, of London, in July, 1863, long before any other claimant appeared in the field. This letter is now in the possession of the Society of Electricians. In this letter Reis says that "*any* sound will be reproduced if strong enough to set the membrane in motion" (the word "any" being underlined); and, as it is known that instruments made after the model of Reis's will transmit speech, it would seem clear that Reis's instrument was as much of a speaking as of a musical telephone. Prof. Silvanus Thompson, who has made a careful study of the subject, says that Phillip Reis was the undisputed inventor of an instrument which he called the telephone, which can now be used to transmit speech, which was then used to transmit speech, and which was invented on purpose to transmit speech. Going still further, Prof. Thompson shows that there is not a single telephone in the exchanges of England in which the fundamental principles of Reis's telephone are not the essential and indispensable features.

This being the case, it may be asked why Reis did not make of his instrument a commercial success. Prof. Thompson answers to this that he was a "poor teacher," and that he was overtaken by severe illness, which ended his career on January 14, 1874. This, says Prof. Thompson, was fifteen years after the telephone had been first described to the Physical Society of Frankfort; and two years afterwards Bell's instrument, the magneto-telephone, was described in all the scientific papers, and attracted the attention of speculators. The most important exhibition of Reis's telephone was at Giessen, in September, 1864, at the meeting of the German Naturalists' Association; but, although experiments were conducted before the most experienced scientists of Germany and several foreigners, no one save Reis appears to have apprehended the great value of the invention from a commercial standpoint. Prof. Thompson gives the testimony of nine contemporary witnesses, who were either personally acquainted with Reis or had experimented with his instruments years before the introduction of Bell's or Edison's telephone.

This is the story of the telephone, and neither the student nor the casual observer can hope to understand it when he who originated the idea is considered from the same standpoint of merit as they who carried it forward to a commercial success. The bootjack, for instance, performs a valuable work; but if there was no boot to pull off, it would be valueless; so a man who originates an idea performs a service compared to which the value of the work done by him who pulls it out or applies it is insignificant.

The paragraph following the title, "Limit to Telephonic Transmission," is like all the theoretical handiwork of the author, lucid and to the point; but it is to be regretted that Mr. Fiske, who seems to be an adept in the matter, did not dwell longer on this point, and since this work is likely to find much favor, as well with the public reader as with the practical engineer, he had opened to him a fine opportunity to disabuse the public of the prevalent idea that the telephone is about to supersede the telegraph in long-distance transmission, which, outside the laboratory, is not likely to be the case.

In treating the incandescence system of electrical lighting, we think Mr. Fiske has, unintentionally, of course, done grave injustice to the man who, in these later days, succeeded, after nights and days of toil, in perfecting a mechanism which should make incandescent lamps of small intensity a practical success. The credit he gives to Star is just, but the impression he gives that the modern incandescence lamp is but an adaptation of the mechanism put together by Star outside of the use of carbon in a vacuum, will not stand the test of a comparison. Again, such persons as Lane-Fox, who made an alleged improvement in something he had no hand in thinking out, should not be mentioned in the same breath with the man whose property they have filched any more than in speaking of a highwayman and his victim we should say, "these two gentlemen differ as to who is the rightful owner of the loot."

It is not necessary that one should be a partisan in order to render unto each man his own; a just man can allow the claims even of his bitterest foe, and openly deny the claims of his nearest friend as opposed to them.

Mr. Fiske seems to espouse the cause of one who, though making some valuable improvements in the telephone could not even by his firmest ally be credited with having invented it; but, when he finds that another man, many years ago, made some only partially successful experiments in incandescence lighting, he seems inclined to disallow the claims of one who has made a tangible success out of a little more than a crude conception.

We are sure that this is not intentional, but we speak of the effect Mr. Fiske's book is likely to produce in the mind of the public reader who is inclined to adopt the opinions contained in the books he reads.

Under the heading "Electrical Efficiency of Machines," Mr. Fiske gives some interesting and valuable formulæ, and as these seem the most direct way of ascertaining the electrical efficiency of machines they are likely to prove of service to all working electricians.

"Besides the generative efficiency of a machine," says the author, "there is also to be considered its electrical efficiency, or the proportion borne by the electrical energy furnished the external circuit to the total electrical energy generated. It being clear that the electrical energy consumed in the machine is, for practical purposes, wasted, it becomes necessary to reduce this amount to

a minimum, and therefore to first understand upon what conditions it depends.

The most simple case is that of the magneto-machine denoting the resistance of the armature by a, and that of the external circuit by r, and remembering that, as the strength of current is alike in both, the power furnished to the armature, and the external circuit must vary with the potentials due to their resistances we see that

$$F = \frac{r}{a + r}$$

in which F is the efficiency. Thus we see that the smaller the ratio $\frac{a}{r}$ the greater the efficiency of a magneto-machine, so that all useless resistances in the armature coils should be studiously avoided. In the case of a separately excited dynamo, the same formula would apply as far as the armature is concerned, and therefore the same conclusion would be reached. The conditions governing the excitation of the field magnets would vary according to the nature of the exciting force, whether it were a dynamo, a voltaic battery, or a battery of accumulators. In calculating the efficiency of the machine, however, the energy in the armature coils and circuit would have to be calculated from the formula $C^2 (a + r)$, in which a is the resistance of the armature, and r the external resistance, and to this would have to be added the total energy expended in the exciting circuit, calculated by the formula $C'^2 R'$, in which C' is the strength of the exciting current, and R' the resistance of the exciting current. Letting F = the efficiency of the machine," continues Mr Fiske, "C the current, and r the external resistance,

$$F = \frac{C^2 r}{C^2 (a + r) + C'^2 R'}$$

"In the case of a series dynamo, in which the same current traverses the armature, field magnet coils, and external circuit, the energy must divide itself in the ratio of the resistances, so that

$$F = \frac{r}{a + m + r}$$

in which r is the resistance of the external circuit, a that of the armature, and m that of the field magnet coils."

"In this case," says Mr. Fiske, "we see the necessity for reducing, as far as consistent with a sufficiently high E.M.F., the resistance of both the armature and the field magnet coils."

In a shunt dynamo the current in the armature is clearly the sum of the currents in the external circuit and the magnet coils, supposing the shunt to be taken directly from the brushes.

Let C = the current in the armature; then the current in the main circuit must, by the law of branch circuits, be

$$C \frac{m}{m \times r}$$

and the whole resistance of the circuit:

$$R = \frac{m r}{m + r} + a$$

$$\therefore F = \frac{\left(C \frac{m}{m+r}\right)^2 r}{C^2 \left(\frac{m r}{m+r} + a\right)} = \frac{m^2 r}{a (m + r)^2 + m^2 r + m r^2}$$

In this case the best relative resistances of the armature, external circuit, and field magnets are less obvious, and require a separate calculation. Taking the reciprocal of the above equation, in order to put it in a more convenient form for differentiating, and remembering that the maximum of the reciprocal of F is the minimum of F, and *vice versa*,

$$\frac{I}{F} = F^1 = \frac{a (m + r)^2 + m^2 r + m r^2}{m^2 r}$$

$$= \frac{a m + 2 a m r + a r^2 + m r^2 + m^2}{m^2 r}$$

$$= \frac{a}{r} + \frac{2 a}{m} + \frac{a r}{m^2} + \frac{r}{m} + I. \quad (1)$$

Differentiating, r being considered the variable,

$$d F^1 = \frac{-a d r}{r^2} + \frac{a d r}{m^2} + \frac{d r}{m} \quad (2)$$

$$\frac{d F^1}{d r} = \frac{-a}{r^2} + \frac{a}{m^2} + \frac{I}{m} \quad (3)$$

$$\frac{d^2 F^1}{d r^2} = \frac{2 a r}{r^4} = \frac{+2 a}{r^3} \quad (4)$$

Equating the second term of (3) to zero:

$$\frac{a}{r^2} = \frac{a}{m^2} + \frac{I}{m'}$$

$$a m^2 = a r^2 + r^2 m$$

$$r^2 (a + m) = m^2 a$$

$$r^2 = \frac{m^2 a}{a + m} = m^2 \frac{a}{a + m}$$

$$r = + - m \sqrt{\frac{a}{a + m}}$$

The positive value of r makes (4) positive, and therefore corresponds to a minimum value of F', and consequently to a maximum value of F. The case of a dynamo, whose magnet coils are wound partly in series and partly in shunt, is quite similar. It is obvious that the formula for the proportion of energy commenced in the external circuit, plus that consumed in the series coils (supposing the shunt to be taken direct from the brushes), may be taken from the above formula by simply substituting r^1 for r, in which r represents the sum of the resistances of the external circuit and the series coils:

$$\therefore F^1 = \frac{m^2 r^1}{a (m + r^1)^2 + m^2 r^1 + m r^2}$$

Letting r, as before, represent the resistance of the external circuit, we have

$$F : F^1 = r : r^1,$$

$$\therefore F = \frac{F^1 r}{r^1}$$

and

$$F = \frac{m^2 r}{a (m + r^1)^2 + m^2 r^1 + m r^2}$$

NEW PATENTS—ELECTRICAL—1883.

INDEX OF INVENTIONS FOR WHICH LETTERS PATENT OF THE UNITED STATES WERE GRANTED IN THE WEEK ENDING NOVEMBER 20, 1883.

288,609 Telegraph key; Homer Anderson, Peekskill, N. Y.

288,623 Actuating device for secondary electric clocks; Augustus S. Crane, Newark, N. J.

288,627 Telephone system; William H. Eckert and John A. Seely, New York City, N.Y.

288,629 Housing and insulation of electrical wires underground; Charles C. Gilman, Eldora, Iowa.

288,682 Safety cut-out for electric lamps; Charles J. Van Depoele, Chicago, Ill.

288,691 Telephone signaling apparatus; John J. Carty, Cambridge, assignor to the American Bell Telephone Co., Boston, Mass.

288,786 Dynamo multiple telegraph; Stephen D. Field, New York City, N. Y.

288,790 Underground conduit for electric conductors; J. Edwin Giles, Hazleton, Pa.

288,795 Apparatus for making telegraph cables; Augustin H. Hamon, Paris, France.

288,818 Dynamo electric machine; Alonzo S. Kimball, Worcester, Mass.

288,826 Electric arc lamp; Joseph T. McConnell, Pittsburgh, Pa.

288,829 Dynamo electric machine; Thomas J. McTighe, Pittsburgh, Pa.

288,830 Commutator for dynamo electric machines; Thomas J. McTighe, and Joseph T, McConnell, Pittsburgh, Pa

288,831 Electric arc lamp; Thomas J. McTighe and Joseph T. McConnell, Pittsburgh, Pa.

288,881 Telegraph sounder; Walter C. Smith, Philadelphia, Pa.

288,888 Apparatus for electric lighting on railway trains; William Stroudley, Brighton, county of Sussex, and Edward John Houghton, Peckham, county of Surrey, England.

288,908 Cut-out for telephones; Charles D. Wright and Charles A. Fisher, Petersburg, Ill.

288,909 Automatic resistance cut-out for telephones; Charles D. Wright and Charles A. Fisher, Petersburg, Ill.

288,915 Magneto electric machine; Joseph C. Beeman, London, England.

288,916 Galvanic battery; Sigmund Bergmann, New York, N. Y., assignor to Bergmann & Co., same place.

288,963 Regulator for dynamo electric machines; Joseph S. Beeman, William Taylor and Frank King, London, England.

Among the curious exhibits at the Munich electrical exhibition were a series of photographs representing the various changes and contortions produced in the human face by subjecting the different facial nerves of a patient to the action of electricity. These were the experimental photographs made by Prof. von Ziemssen. The expressions of joy, pain, surprise, doubt, disgust, &c., were easily realized, according to the nerve that was touched by the electrode. Other experiments by Prof. von Ziemssen promise to be of great importance. They institute a comparison between the continuous and the induced current in the stimulation of the important accelerator and depresser nerves which control the heart. He has found that an induced current, so far from stimulating the nerves of the heart, as heretofore believed, is perfectly inoperative; whereas a continuous current from an ordinary battery is of the very greatest activity.

Combined Gas and Electrical Light.

M. Somzee has made another attempt to produce a cheap and brilliant light by the combination of gas and electricity. The arrangement comprises an ordinary gas flame, fitted with a curved metallic rod passing through the flame, provided with means for preventing overheating under the action of the electric current, which is taken from a secondary battery. It is claimed that under these conditions the illuminating power is considerably augmented in proportion to the additional expense. The light is also said to be white, and much cooler in respect of radiation than a corresponding light from gas alone; the relative proportion of luminous and heat rays being completely changed. What is supposed to render this combination practicable is the fact that the platinum does not require a great intensity of current, and that one or two small elements will suffice to supply an ordinary light, and make it give four or five times more light at a cost three times less than gas. According as the intensity of the current is increased or diminished, the flame may be rendered more luminous or hotter, as the case may be, so that the arrangement is capable of furnishing all gradations, from the brilliant flame to the most calorific radiations.

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Hudson River Telephone and Telegraph Company	100
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Suburban Telephone Company	139
Southern Bell Telephone and Telegraph Company	125
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Central Union Telephone Company	100
Iowa Union " "	100
Missouri and Kansas Telephone Co.	90
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Bell Telephone Company, of Missouri	165
Wisconsin Telephone Company	125
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Michigan Telephone Company	115
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Erie Telephone Company	59
Union Telephone Company	100

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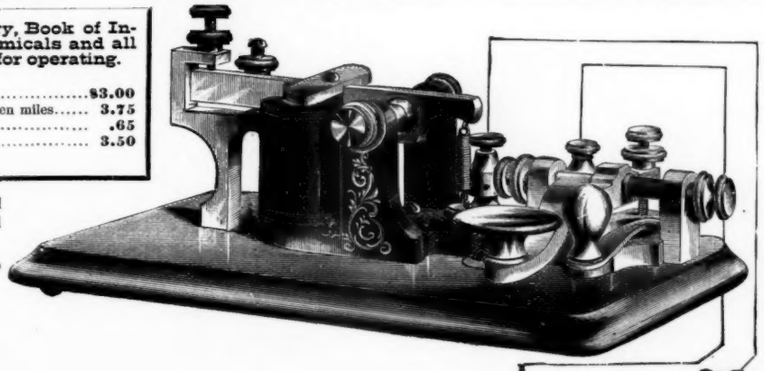

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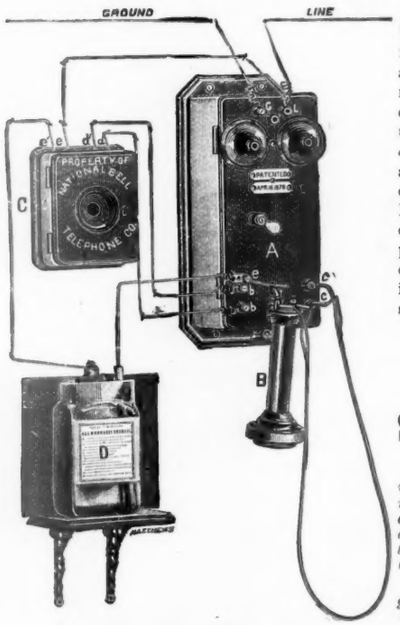

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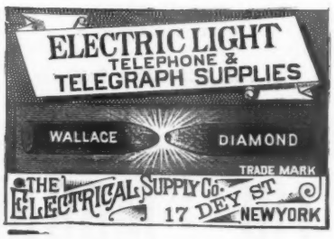

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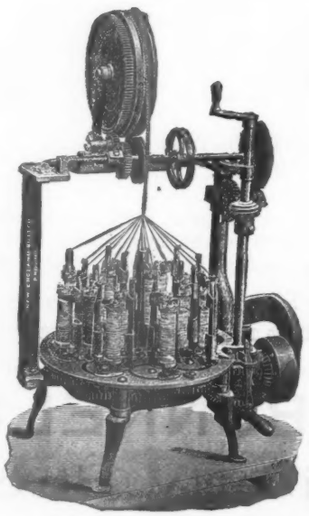

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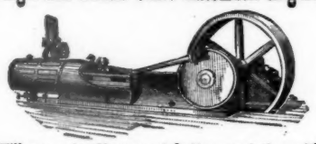

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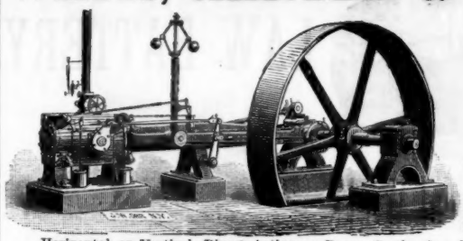

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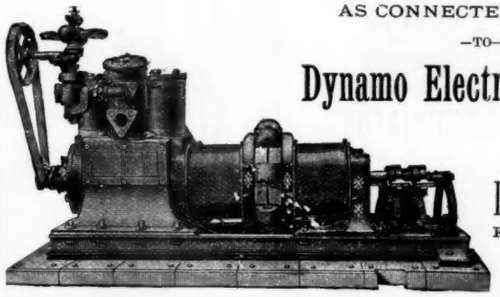

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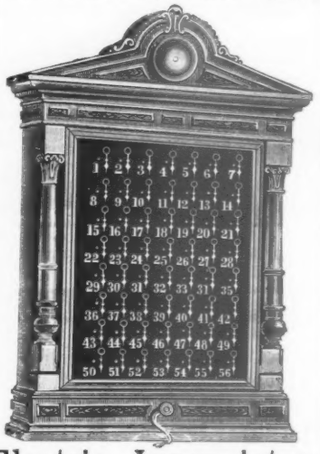

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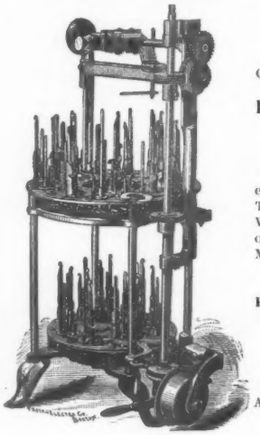

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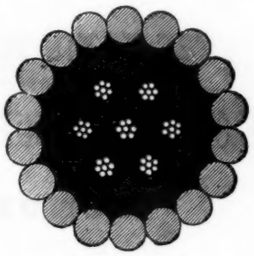

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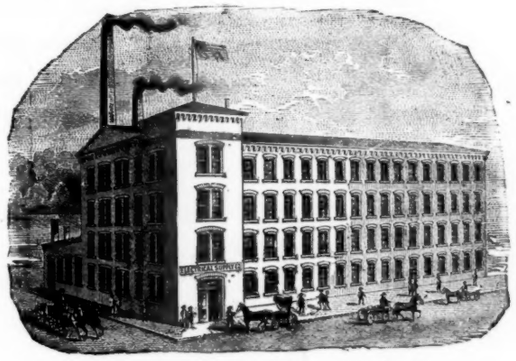

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